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THE INTERNATIONAL WEATHER-SERVICE.

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THE "weather" is that mystic word which sums up the physical influences most affecting the human frame for good or ill. The splendid, ever-varying panorama of the sky, the benign mutations of the seasons, the immense pulsations of the atmosphere furnished, however, for ages, themes for the poet rather than for the philosopher. In the presence of its tremendous though cloud-veiled forces, as the high priest of old on the entrance of the sanctuary, we tread with awed footstep. From time immemorial its phenomena have engaged the daily and deepest attention of men; and the ever-popular, ever-compulsory study of their changes, in the language of all civilized nations, has been called "meteorology," which literally means "the science of *the sublime*." "Distance and time," says the physical geographer Ansted, "seem annihilated when we watch the action of these mysterious influences, and we may almost recognize the reality of an existence unhampered by natural impediments when we find an instantaneous response of our innermost senses to a material stimulus applied within the burning atmosphere of the sun." But the overmastering interest and awe, awakened by the terrestrial atmosphere, through which this stimulus reaches us, are intensified by the consciousness that upon it we depend for vital breath, and that it is the medium through which an invisible hand sweeps every chord of humanity.

It is to that grand and systematic investigation of this physical agent, which has recently been commenced by the concert of the nations, in a system of world-wide "Simultaneous" observations, known as The International Weather-Service—to its history, methods, and utilities—we would now direct the reader's indulgent attention. Be-

fore doing so, however, it will be necessary to glance at the advances in weather-research that have led to this undertaking.

The exploration of the vast body of water which surrounds the land-masses of the globe has been, since the sixteenth century, rapidly prosecuted. Its configuration has been determined, its tides have been weighed, its gulf-streams and counter-currents gauged, and even its abyssal depths sounded and surveyed, until we can now hardly speak, save by poetic license, of "the dark, unfathomed caves of ocean." But the exploration of that other and almost boundless ocean of air which envelopes the whole earth and whose winds sweep its surface, swaying the waters of the sea and affecting every form of terrestrial life, has progressed but slowly. The upper atmosphere is pierced by but few of the earth's mountain-peaks upon which meteorological stations can be efficiently maintained, while the spasmodic attempts at aëronautic investigation of the cloud-land, daring as they have been, have realized less knowledge of its currents than that which Columbus in his voyages of discovery acquired of the circulation of the equatorial waters. Investigation has been, therefore, perforce restricted for the most part to the phenomena of storms, cyclones, and anti-cyclones, moving at the bottom of the great sea of air—phenomena involving such insignificant portions of the atmosphere, when compared with the superincumbent mass, that a leading meteorologist has hyperbolically likened them to ordinary "smoke-rings." Even in the lower atmospheric strata, the different national bands of observers have been widely separated—here and there an ocean unsentineled rolling between them—so that their collated reports conveyed no clearly connected account of the transcontinental movements of air; and it is to-day disputed by some that North American storms cross the Atlantic to western Europe. But, worse than all else, the observations taken by the most painstaking and indefatigable observers were, until recently, systematically vitiated, not only by a lack of uniformity in the methods, but by the more fatal lack of uniformity in the hours of observation. What would be thought of a little army confronting immense odds, some of whose regiments had one plan of battle and some another, some asleep when others were engaged, but none acting simultaneously? Yet, such is a fair representation of the world's observational force which was expected to attack the great problems of meteorology, as it was until less than a decade ago.

In 1870 the United States entered the field of weather-research; and, for the first time in the history of meteorology, there was then established a broad system of simultaneous observations and simultaneous reports of the weather. These reports were immediately worked up and graphically embodied in the simultaneous weather-maps, issued thrice daily from the office of the Chief Signal-Officer, U. S. A., General Albert J. Myer, whose original and announced plan was to observe the weather over the whole country "*at the same mo-*

ment of actual (not local) *time*," as was stated on every weather-map. This conception aimed at the rescue of meteorological researches from that disorder and disconnectedness which had always characterized the observational work. The prime object was to gain a daily *conspectus* of the atmosphere over the country as it *actually* was, and as it would be seen if a *photographic* view of it, so to speak, could be taken. The simultaneous method, when announced, seemed so natural and simple that one might have wondered that any other was ever attempted. Observations called "synchronous" had been, indeed, before this time, energetically made in several countries; but the term "synchronous" was used to signify that every observer read off his instruments at given hours of his own *local* time, and not at the same moment of physical time. Etymologically, there might be little or no difference between "synchronous" and "simultaneous," but, for all the purposes of atmospheric investigations over a vast territory like that of the United States, the practical difference was by no means insignificant. When observers, who on the old "synchronous" method reported the weather-status each at the same hour of local time, were separated by hundreds of miles, their reports failed to represent the actual fluctuations of the atmosphere and the true bearings of its cyclonic and anti-cyclonic movements; so that, when the meteorologist came to compare and chart the combined data, they yielded necessarily a distorted or untrue picture of the ever-restless aërial ocean. On the other hand, in the "*simultaneous*" method, since all the observers over the wide field of the research read their instruments at one and the same moment (7.35 A. M. Washington mean time), their reports, when charted, gave a true and life-like representation of the physical phenomena as they actually coexisted and conspired. As on the screen of the artist's camera the sun instantly paints the true image of the human face before its expression can be changed, so does the process of simultaneous observation seize and secure all the elements necessary to delineate the current physical features and conditions of the atmosphere, as existing at a *fixed* moment, and before they can have time to undergo change. Simple as this expedient is, it is evidently the key to all effective research in a vast gaseous ocean whose currents and waves are ceaselessly rolling and rapidly altering their geographical bearings, even while the sun is quickly passing from one meridian to another. Were all the weather observers of the world to read off their instruments as it were by a given tick of one clock, their collective data would furnish materials for the most exact delineations of the complex atmospheric machinery which it is possible to obtain. Instead of piling up a mass of weather bulletins unsuited for purposes of a rigidly scientific inter-comparison, as was so long done,* they would contribute

* In the old system of telegraphic weather-reports established by the Smithsonian Institution, the observers reported at 8 A. M., 2 P. M., and 9 P. M., each at his own *local* time. Accordingly, their reports could not give exact results. To take a not uncommon

solid and coherent facts of nature, all ready to be put together and worked up by the meteorologist into a noble and useful science.

Having noticed the first attempt ever made to establish a system of "Simultaneous weather-reports," and indicated the unique character of the system, as carried out by the United States since 1870, we hasten on to the history of its extension to the vast field of *international meteorology*. In September, 1873, the International Meteorological Congress was convened at Vienna, to consider all the graver questions that were then agitating public and private investigators, as to the progress of weather-science. The Congress was composed of official representatives, charged with the meteorological duties pertaining to the researches of their respective Governments. It was then proposed by the representative of the United States, General Myer, that "*it is desirable, with a view to their exchange, that at least one uniform observation, of such character as to be suited for the preparation of synoptic charts, be taken and recorded daily and simultaneously at as many stations as practicable throughout the world.*" This proposition was unanimously concurred in, and its hearty adoption by the Congress, the members of which virtually legislated for the nations they represented, at once secured the extension of the American "simultaneous" system (as inaugurated in 1870 for the United States) to the entire field of weather investigation then covered or yet to be covered by the observers of all the nations.* Soon after the adoption of this proposition at Vienna, by the courteous coöperation of scientific men and the chiefs of the meteorological weather-bureaus of the different countries, records of uniform observations, taken daily and simultaneously with the observations taken over the United States and the adjacent islands,

example of a storm central at Omaha at 8 A. M. and moving toward New York: since the difference of actual time between the two cities is nearly one and a half hour, and the storm-center might be progressing at the rate of forty-five or fifty miles an hours, the Omaha report would represent its bearings, as respects New York, from sixty to seventy miles *out of its true place!* So also all observers not on the meridian of New York would more or less mis-locate the center. Since nearly all cyclones and anti-cyclones move from east to west or from west to east, and very few in a meridional direction, the systematic misrepresentation of their relative positions in point of *longitude* works grave defects. A weather-map based on such non-simultaneous reports, instead of faithfully mirroring the sky overhanging a continent, necessarily gives it rather a *wry* face. Even at this date, we can not say that all European weather-stations take observations simultaneously. So far as they do, their present method is shaped after that introduced originally in this country by General Myer, in 1870. Professor Espy called his observations "simultaneous, or nearly simultaneous"; but evidently they were taken at the same hour of *local* time, and were, therefore, less "simultaneous" than the Smithsonian.

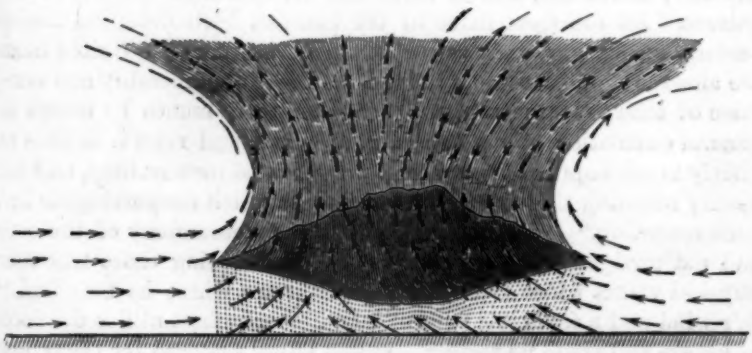
* Referring to an exchange of United States weather-reports with those of Canada, the Chief Signal-Officer, in his annual report for 1872, said: "It is to be hoped the system may be extended in the Canadas, and the coöperation be yet closer, this connection of the services becoming the first link in the grand chain of interchanged international reports destined with a higher civilization to bind together the signal-services of the world" (p. 83). The same scheme he had foreshadowed in a public document dated January 18, 1870, and also the plan of using ocean-cables for storm-warnings.

were commenced, and since then have been exchanged in semi-monthly communications. These reports, steadily increasing, now cover the combined territorial extent of Algiers, Australasia, Austria, Belgium, Central America, China, Denmark, France, Germany, Great Britain, Greece, Greenland, Iceland, India, Italy, Japan, Mexico, Morocco, the Netherlands, Norway, Portugal, Russia, Spain, Sweden, Switzerland, Tunis, Turkey, British North America, the United States, the Azores, Malta, Mauritius, the Sandwich Islands, South Africa, South America, and the West Indies, so far as they have been put under meteorological observation. On July 1, 1875, the daily issue of a printed bulletin, exhibiting these international simultaneous reports, was commenced at the Army Signal-Office in Washington, and has since been maintained. A copy of this "International Bulletin" is furnished each coöperating observer. This publication combines for the first time of which we have any record the joint labors of the nations in a research of this kind for their mutual benefit. As the network of coöperating stations already spreads over so vast a proportion of the land-surface of the globe, there is needed only the more general coöperation of the naval and merchant fleets of the world to supply ample data for a comprehensive study of the atmosphere as a unit. This need is now growingly appreciated, and nine series of marine reports, each containing the simultaneous observations of a number of sea-going vessels,* have been added to supplement the similar reports contributed by the land-observers, swelling the total observational force to 500 laborers. The harvest of physical data already garnered by this force, and daily increasing, will be invaluable for all future weather investigations. As the Committee of the Scottish Meteorological Society recently said, "This truly cosmopolitan work, which the United States are alone in a position to undertake, thanks to the liberality and enterprise of their Government, will bring before us month by month the general circulation of the earth's atmosphere, and raise if it does not satisfy many inquiries lying at the very root of meteorology, and intimately affecting those atmospheric changes which meteorologists have been recording." It will greatly enrich the meteorology of the ocean and aid navigation, by supplying data for deducing those true mean physical values which teach the mariner at sea where he may find "a fair wind and a favorable current," how he may best utilize the forces of nature and elude its terrors. It will afford material for the renovation of the climatology and sanitary meteorology of regions not now fully investigated. But, above all, it will facilitate the elucidation of the laws of storms and those associate phenomena which conspire to produce the many-colored phases of "the weather."

The cardinal object of this vast scientific enterprise, as the reader may anticipate, is the study of the atmosphere as a *unit*. The atmospheric ocean must be viewed by every thinking mind as a whole, whose

* The number of marine observers now exceeds one hundred.

complex parts act interdependently—as the various parts of a steam-engine—yet all constituting one grand mechanism. Nature's forces respect no national frontiers; and, if their mighty play is to be watched by science, its observational corps must be expanded to cover every accessible part of the globe. This will be made more apparent if we consider the intensities and movements of cyclones. The storms generated over the sea often push with resistless energy against the loftiest mountain-walls, and, surmounting their acclivities, press on as if they had felt no retardation, to sweep across an entire continent, and then, untired, to take a fresh start on a long ocean-voyage. In a rigid examination of the Signal-Service data for a period of twenty-six months, twenty-eight storm-centers, it was found by Professor Loomis, traveled eastward across the Rocky Mountains, and reached the Mississippi Valley in unimpaired vigor, having scaled that imposing barrier, 10,000 feet high, as easily as the steamship on its rapid course overrides a wave. In discussing the two cyclones which visited the Bay of Bengal in October, 1876, Mr. Elliott, Meteorological Reporter to the Government of Bengal, incidentally gives us some idea of the cyclopean forces which are developed by such storms. The average "daily evaporation," registered by the Bengal instruments, in October, is ".2 inches."* The amount of heat absorbed by the conversion of this amount of water daily over so large an area as the Bay of Bengal is enormous. "Roughly estimated," says Mr. Elliott, "it is equal to the continuous working power of 800,000 steam-engines of 1,000 horse-power." A simple calculation will show that it

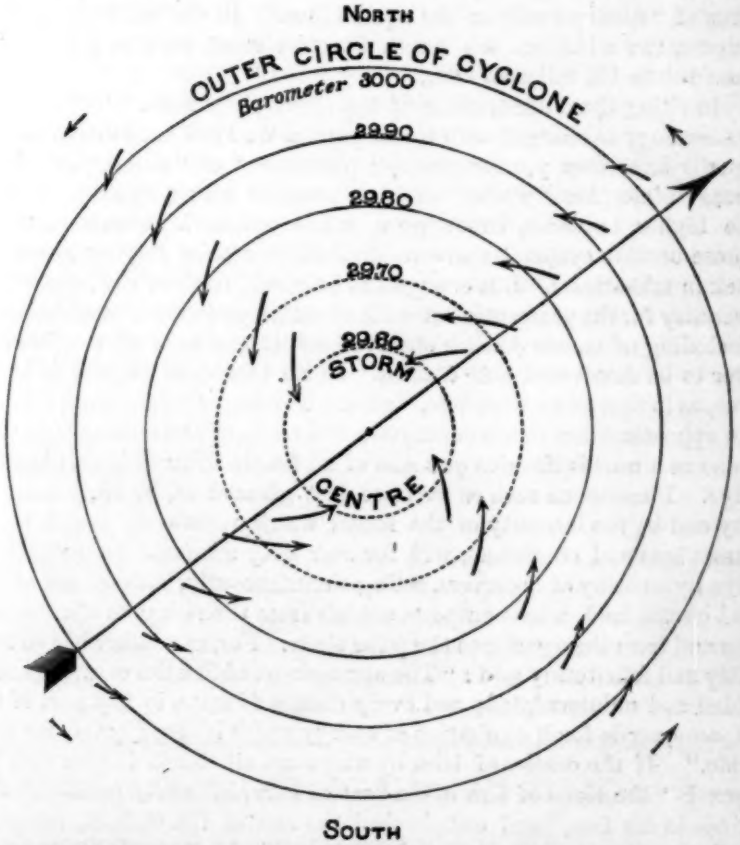


VERTICAL SECTION OF THE HEART OF A CYCLONE. (Arrows show direction of wind and the *ascending current* in storm-center; the dark-shade, nimbus, or rain-cloud.)

suffices to raise aloft over 45,000 cubic feet of water in twenty-four hours from *every square mile* of the bosom of the bay, and transport it to the clouds which overhang it. When we extend the calculation from a single square mile to the area of this whole Indian gulf, the

* "Report of the Vizagapatam and Buckergunge Cyclones of October, 1876," by J. Elliott, p. 182.

mind is lost in the effort to conceive the force which, in a day's time, can lift 50,000,000 tons! Yet, it would be easy to show that such figures, fabulous as they seem, do not adequately represent the cyclonic forces of a single storm. "The usual size of the cyclones in the Bay of Bengal," according to Piddington, "is from 300 to 350 miles; but," as he adds, "it would appear that they sometimes much exceed that extent"; and others give the average diameter as still greater than 350 miles. Now, in the passage of a cyclone over such a sheet of water, the vapor which has been slowly generated over its surface for many days is rapidly condensed and reconverted into water, and falls in the shape of torrential rains—as Dampier declared, "faster



HORIZONTAL MOVEMENTS OF AIR AROUND CENTER OF CYCLONE IN NORTHERN HEMISPHERE.—(Large arrow shows path of storm; smaller arrows, the winds taking a more *radial* direction, and *increasing in velocity*, as they near the center.)

than he could drink it." On the coasts of India, twenty inches have been known to fall in a single night; in the Bengal storm just mentioned, 15·2 inches fell in eighteen hours. Assuming that the mean

daily precipitation within the areas of storms like those just referred to is only three inches, it is evident that Mr. Elliott's calculation of the mechanical force daily exerted in the work of evaporation falls short of expressing the force exerted in the work of precipitation during a day's march of a cyclone. The latter is, however, but one of the many tremendous agencies engaged in the development of a storm of ordinary magnitude in the intratropical regions. In the extratropical and high latitudes, cyclones are much more extensive, "being seldom less than 600 miles in diameter, but oftener two or three times that amount, or even more" (Buchan); while the waves of the sea, driven by their winds, beat upon the seacoast, as Mr. Stevenson, the well-known English engineer, has estimated, with the almost incredible force of "6,000 pounds on the square foot." In the hurricane of last August, the winds on the North Carolina coast blew at the rate of from 138 to 165 miles an hour.

In citing these illustrations of the storm-phenomena which modern meteorology is charged with investigating, we have not alluded to the equally important yet far grander phenomena of "anti-cyclones," or those "atmospheric waves" of high pressure which, emanating from the higher latitudes, submerge a whole continent at once—around whose borders cyclones move as diminutive eddies playing around a rock in mid-stream. But enough has been said to show the imperative necessity for the prosecution of wide-extended or *international* research (including of course *oceanic* observations) if the laws of weather are ever to be discovered and defined. In no branch of physics is it so true, as in that of weather-lore, "a little learning is a dangerous thing." An approximation to the conception and study of the atmospheric machine as a *unit* is the *sine qua non* of all future advance in this knowledge. Phenomena such as we have just glanced at, by their immensity and by the intensity of the forces which resistlessly propel them across seas and continents, will for ever defy adequate investigation, save by an army of observers, acting simultaneously, both on the ocean and on the land, whose outposts stretch from the rising to the setting sun and from the equator to the polar circle. For, as another has so forcibly and felicitously said: "The atmosphere, unlike the ocean, is undivided and uninterrupted; and every change of state, in any part of its expanse, sends forth a pulsation of energy which is speedily felt far and wide." If the oracles of Him by whom are all things declare that he spreads "the cloud of dew in the heat of harvest," who "gathereth the winds in his fists," and once hushed the roar of the Galilean tempest, well may these wonders, ever fresh from his hand, enlist the earnest and inspiring study and observation of intelligent men everywhere. Our favored planet, not like the airless moon, is folded in the kindly bosom of an atmosphere which, while ministering nourishment to man and accommodating itself to all his movements and vicissitudes, interposes as his shield against the fiery influences of the solar system, even to

arresting and consuming those countless meteoric stones, showered upon us from stellar space, before they can penetrate to the lower aërial strata. For us, at least, in respect to this sublunary scene, it is of engrossing interest, as that all-pervading organism which

> "Lives through all life, extends through all extent,
> Spreads undivided, operates unspent."

In the technical execution of this purely pioneer work, the first step was the preparation of a daily graphic and synoptic chart exhibiting all the weather observations taken simultaneously in the northern hemisphere. On the 1st of July, 1878, the Signal-Office at Washington began the regular publication of a *daily international weather-map*, charted daily and issued daily, each chart being based upon the data appearing in the "International Bulletin of Simultaneous Reports" of similar date. The daily issue of a weather-chart of this kind and scope is without a precedent in history. It illustrates the coöperation, for a single purpose, of the civilized powers of the globe north of the equator, and brings the atmospheric phenomena over the whole field of the research, and in their true relations to each other, within the easy comprehension of the student's eye. (See frontispiece.) As these charts in successive order are spread out day after day, the investigator has before him a vivid *panorama* of the physical forces in pictured action, so that he can readily trace their mutual dependence and interaction in the normal working of the ponderous, yet beautiful, atmospheric machinery.

The history of progress in the discovery of physical phenomena and their laws is intimately connected with the introduction of technical contrivances so simple that at first they attract little notice. After the invention of the mariner's compass, and the astrolabe, nothing perhaps that was done for geographical science gave it such an impulse as the chart introduced in 1556 by Gérard Mercator, by which the earth's entire surface was presented in a single picture to the geographer's eye, and by which (the degrees of latitude and longitude at all places bearing to each other the same relations they bear on the sphere itself) the navigator could readily steer his ship in straight lines. This simplest of contrivances became, in a word, an invaluable instrument of maritime exploration and discovery, the present and almost exclusive employment of which by mariners of all nations, as *the* chart for the ocean, has brought the name of Mercator down to this day in honored remembrance. Not to dwell upon the charts of Paolo Toscanelli in the fifteenth, and of Martin Behaim in the sixteenth century, so justly celebrated—the former as guiding Columbus on his great westward voyage, and the latter as blazing Magellan's perilous way toward the southern shore of South America, to circumnavigate the globe—we may well say, "Accurate maps are the basis of all inquiry conducted on scientific principles." The "International Weather-Map of Simulta-

neous Observations" is a generalization in itself, and offers the meteorologist every day a *bird's-eye* view of the aërial world as it actually was at that fixed moment of physical time when all the observations embodied in it were made. Nothing can be simpler or more intelligible to even unscientific eyes than a chart which, by means of suggestive symbols, displays the different elements of the weather over a hemisphere, each in its own color. Just as Mercator's projection represents the entire ocean to the mariner—as if there were no horizon or sphericity—and all objects in their true meridional bearings to each other, so the "International Weather-Chart" depicts the aërial ocean in its beautiful integrity and all its parts in their true physical relations to each other, as certified by strictly simultaneous reports. Of course, the two charts are entirely independent and different; but we refer to the invention of the old Flemish geographer merely to illustrate and enforce the immense value of every really synoptic chart as a weapon of research and as a medium of scientific discovery.

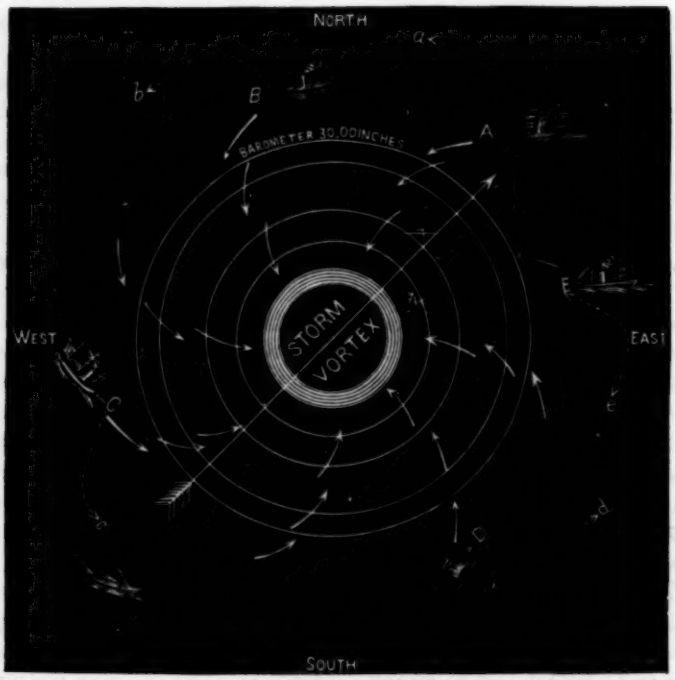
The cartographic method, by which truly synoptic views of the atmosphere are obtained, is indeed the natural accompaniment and handmaid of the method of "simultaneous weather-reports," both of which are peculiar to the national weather-service inaugurated at Washington in 1870, and, through the adoption of General Myer's proposition at Vienna, in 1873, extended to the new international weather-service. Without "simultaneous" weather observations, it is obvious, no truly "*synoptic*" weather-chart is possible; and, as has been said, the first "simultaneous" observations were those instituted by the United States in 1870. The unique and novel feature of the international weather-charts, and the feature which will most commend them to meteorologists, is that they furnish a faithful pictorial history of the atmosphere and its revolutions, enabling the inquirer to trace its currents and counter-currents, to witness the behavior of its cyclonic storms and other barometric waves as they traverse continents and deploy upon the ocean, and to form clarified conceptions of its massive yet orderly machinery. The well-known English journal of science, "Nature," "earnestly hopes that the navies and the mercantile vessels of all nations will soon join in carrying out this magnificent scheme of observations, originated by the Americans in 1873, and since then further developed and carried on by them with the highest ability and success." Its French namesake, "La Nature," said recently, when speaking of this service, "One ought not to be surprised to learn that the United States, encouraged by their first successes, are to attempt a new extension of a system of observations which has already, in so few years, produced considerable results." It would not be an easy task to predict the future results to be obtained by such a system of investigation; but we may confidently conclude that no system of weather inquiry ever before undertaken promised a richer harvest of meteorological lore than that which rigidly follows up its *simultaneous* obser-

vations and amasses its corresponding charts. Every coöperator in the work, it should be added, is encouraged and stimulated by the fact that a daily copy of both the "International Bulletin" and "Chart" is furnished by the United States, without cost, to each observer, on land or at sea, of whatever nation, who, at the request or with the sanction of the Chief Signal-Officer, coöperates in the enterprise.

We come now to the question of the practical application and utility of the data and charts published in connection with the international weather-service. And here the embarrassment arises from the multiplicity of matters, affecting almost every interest and industry of mankind, upon which this service will bear. There is not a profession, or trade, or handicraft in society which is not at every turn more or less influenced by the weather, and compelled to act upon some kind of weather-forecasts. No sooner had the Weather Bureau commenced its daily publication of "Probabilities" or "Indications," in 1870, than "whole troops of practical applications" of the data sprang into existence. It will be so with the international bulletin and charts of simultaneous meteorology.

One of the first practical applications of the simultaneous observations over the northern hemisphere will be realized in the elucidation and correction of "*the law of storms*," and of the rules for the extrication of ships from the storm-vortex. Great have been the intellect and learning employed in the settlement of this question, so important to commerce and navigation. The time-honored researches of Redfield, Reid, Espy, Piddington, Thom, and others of the past, supplemented and harmonized in a measure by those of living laborers in the storm-field, have indeed established the existence of a "law of storms" upon an unassailable foundation. But they have not defined some of its cardinal conditions. The definition of storms as "revolving gales," in which the winds blow in *concentric* circles around a calm center, has been rudely damaged by the facts every day brought to light. And the contrary theory, that the storm-winds blow in *radial* lines toward the vortex, has not fared much better. The intermediate hypothesis, that the winds blow in regular *spirals* around the center, while it apparently reconciles some of the otherwise conflicting facts, and has given a temporary quietus to the storm controversy, strictly speaking, is not less objectionable than either of the theories it affects to correct: for it apparently obliterates, or seemingly ignores, the two large and distinct classes of indisputable wind-phenomena upon which the rival deductions of Redfield and Espy were respectively based. Time has fully demonstrated the insufficiency of both the "circular" and the "centripetal" theory to account satisfactorily for all the salient and phenomenal features of a cyclone, but it has attested the immense value of them both as scientific approximations to the truth. But, it must also be said, the theory of "spiral" currents arranged symmetrically around the storm-center does not furnish a complete so-

lution of the problems raised by a study of cyclone observations. In the domain of practical "nautical meteorology," and in its applications to the handling of ships on the outer circles of revolving gales, it is especially yet to be sifted in the light of the most exact "*simultaneous*" observations. The international weather-charts, illustrating the exacter forms of marine storms, show us that they assume very eccentric shapes (see chart, p. 305), and consequently develop variant wind systems. On the liquid expanse of the stormy North Atlantic, crowded with the steamers and sailing-ships of all nations, there exists the finest field for this investigation to be found on the globe. When these vessels become "floating observatories," rendering up accounts of their daily simultaneous weather experience, it will be comparatively an easy matter to set for ever at rest the yet disputed questions of the phenomena of cyclones, and to formulate rules for manœuvring ships so as to elude their crushing forces.



MANŒUVRING SHIPS ON THE EXTERIOR OF A CYCLONE. (The dotted lines *Aa*, *Bb*, *Cc*, *Dd*, and *Ee* show the paths of *escape* from dangerous positions; the large arrow, the storm's progressive direction; the small arrows, the cyclonic winds.)

The birth, life, and death of storms; their translations from continent to continent, with the times and directions they take in such transits; the thermometric, baric, and wind conditions around the globe at various parallels; the distribution and amount of rainfall and snowfall; the laws of our great "hot waves" and "cold waves," with many

other data for settling questions of climatology, and possibly of forecasting in some degree the character of coming seasons—are some of the practical problems of every day's life which the international charts and bulletins will serve to simplify or solve. Among these, none perhaps calls for an earlier and exacter solution than the translation of cyclones from the Asiatic waters over the North Pacific Ocean to the Pacific slopes of the United States, and the kindred question of the transatlantic passage of American storms to western Europe. As we have already seen, so far as critical examination has been made of the Signal-Service weather-maps, more than one cyclone from the Pacific coast every month, on an average, overleaps the Rocky Mountains and travels eastward, reaching the Mississippi Valley and the Lakes, with its original (perhaps ocean-born) strength. The ocean is preëminently the birthplace and habitat of storms. Thence, when fully formed and densely stored with aqueous vapor—the fuel of the cyclonic engine—they assail the land-masses of the earth, and, traversing them, unless *in transitu*, they perish for want of water, and return to their native element. This is no less true of the Great Ocean that washes our Western shores, notwithstanding its name, than of the "stormy Atlantic." Uncomfortably near as the West Indian hurricanes approach our Atlantic seaboard, they affect but comparatively a small strip of the Eastern half of the United States, and often give us a wide berth. But the storms which invade our Pacific seaboard, from southern California to the mouth of the Columbia River, exert or expend their full force within the national limits, and frequently cut their broad swaths entirely across the country. The golden key, therefore, to our continental meteorology is the adequate knowledge of the barometric depressions and associate "waves of high pressure" which roll over the continent from the westward, and, in their progress, dominate the weather to the north of the thirty-fifth parallel.

Off the California coast there exists, throughout the year, a permanent area or wave of high atmospheric pressure, or a vast "anti-cyclone"—the diameter of which is something like one thousand miles. The barometer in this area reads 30·20 inches (see chart, p. 309). From its northern and western slopes, westerly and northwesterly wind-belts extend in an easterly direction across the Coast and Rocky Mountain ranges. The immense stationary anti-cyclone, from which flows off this broad belt of westerly winds, is probably due to the continental barrier arresting and accumulating the perennial equatorial current from the central zone of the Pacific Ocean; and has its counterpart in the similar area of high pressure lying in the Atlantic, off the coast of Spain and south of the Azores. The great "*highway*," therefore, along which the chief atmospheric currents move and introduce on our continent the storm-controlling and weather-producing influences, begins on the Pacific coast and traverses the country from west to east. As the Atlantic dominates the weather of Europe lying on its eastern

shores, so in the Pacific Ocean is the cyclopean workshop of the atmosphere, in which are produced and whence are sent forth the meteors that perpetually travel over North America, and substantially mold its climate and weather. To cover the North Pacific, therefore, with a network of "floating observatories," contributing their "simultaneous weather-reports" to the Signal-Service Bureau, is one of the grand desiderata of American meteorology. A ship at sea is one of the best of stations for a simultaneous meteorological system. The value of its records is enhanced by the considerable change of the ship's location occurring once every hour; and the law of self-interest at least should compel every shipowner and shipmaster to enlist in a joint observational work which inures to his own safety and lends a helping hand to every meteorologist. Without the data, to be collected only by vessels sailing on the North Pacific, the prevision and prediction of storms and weather-changes that transpire in the Pacific and Western States, and are thence propagated to the East, can not be put upon a sure footing. With such marine simultaneous data, the work of weather-forecasting and storm-warning for the Pacific coast and the whole country will be greatly simplified, and the accuracy of the work much enhanced, if not assured. If the solar light of day comes first from the East, we may nevertheless predict that the flood of scientific light necessary to elucidate the still obscure phenomena of American, and especially Western meteorology, will break upon us from the Great Western Ocean. "The *improvement*" in the national tri-daily "Indications," etc., of the Signal-Service, which General Myer hopes for, as his oceanic simultaneous work "progresses," can not be doubted.

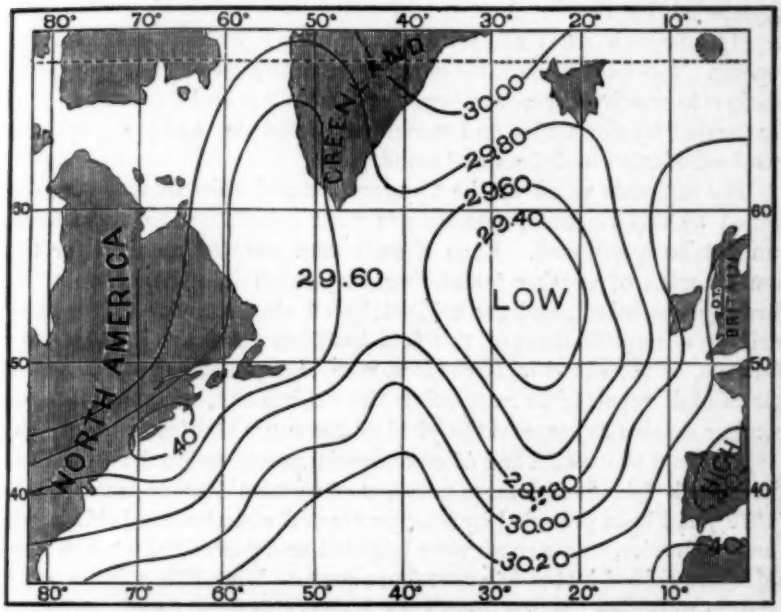
If anything more is needed to enforce this view of the immense value of North Pacific researches for the development of American weather-telegraphy, it is found in the fact that the cyclones of that ocean recurve from the Asiatic coast, and follow the warm current known as the "*Kuro Siwo*," or "*Japan Current*"—the congener of our Atlantic "Gulf Stream"—in its northeasterly extension to the northwestern coasts of the United States. This mighty "river in the sea" is a natural storm-channel. "The influence of the Kuro Siwo," says Captain Silas Bent, the original and careful investigator of its phenomena, "upon the climate of Japan and the west coast of North America is, as might be expected, as striking as that of the Gulf Stream on the coasts bordering the Atlantic." And Kerhallet, the well-known French hydrographer, tells us that it "crosses all the northern part of the Pacific Ocean, and makes itself felt on the northwest coast of America." "The track of typhoons in the China Sea," according to one of the highest nautical authorities, Labrosse, "lies between north-northwest and south-southwest, then toward the north, and afterward turns sharp around *toward the east*, in the direction of the Bashee Islands," whence in 1854 Mr. Redfield traced a number of them far away toward the American coast. These terrific rotatory gales rival, if they

NORTH AMERICA
BEHRING SEA
SEA OF OCKHOTSK
ASIA
SIBERIA
CHINA
SEA OF JAPAN
NORTH PACIFIC OCEAN
SARGASSO SEA
Current and Drift
Kuro Siwo
Equatorial Current
Northern
Sandwich Is.
Bonin Is.
Philippine Is.
Hawaiian Is.
CHART OF STORM TRACKS
IN THE
NORTH PACIFIC OCEAN
Note Dotted lines represent Storms as traced by Mr. Redfield and others.
Zinesinghall " " " Signal Service U.S. Army.
EQUATOR

do not exceed, in intensity, the fiercest Atlantic hurricanes. The cyclone or typhoon of the U. S. steamship Mississippi, October 6, 1854, with that of the U. S. storeship Caprice, and the steamship Susquehanna, July 17 and 19, 1853, in Commodore Perry's Japan Expedition, are among the most memorable storms of history on any sea, and illustrate the magnitude and might of those atmospheric forces so characteristic of the Great Ocean, whose meteorology is now to be brought under strictly simultaneous surveillance and studied in its close causal connections with that of our own country.

As the investigation of the Pacific's meteorology is so important to America, the same system of observations applied to the Atlantic reaches to the roots of European meteorology. It is well known that the atmospheric conditions which shape European weather and climate are propagated over the French and British coasts from the Atlantic, so that every intelligent storm-warner and weather-forecaster in Europe casts a wistful eye to the western waters to catch some premonition of what is to befall his coasts. Propositions to buoy in the mid-Atlantic ships, equipped with self-registering barometers and weather-indicators and connected by telegraphic cables with the shore, which would flash reports of precursory changes to the central Signal-Office, were suggested by General Myer to meet a deeply-felt need. It has also been very seriously proposed to dispatch carrier-pigeons by the westward-bound English steamships, to bear back weather-reports from points two hundred or more miles at sea, in the hope that the London office might have data for more timely weather-warnings. "It is possible," says the Russian meteorologist Wœikof, "that in October *Atlantic storms may reach as far as Yakutsk*" (in northeastern Siberia) which is farther from the Atlantic than England is from the Pacific Ocean. "In Europe," Mr. Buchan tells us, "stormy weather is accompanied by a diminution in the atmospheric pressure, the center of which, after traversing more or less of the Atlantic, arrives on the coast of Europe." *One* weather-report from the Atlantic, if only made a few hundred miles from the British coast, would be worth, for all practical purposes of storm-prediction, more than dozens of continental reports. If, indeed, the international system does not supply the needed ocean-reports in time for the European work of daily storm-warning, its daily charts show *the conditions which usher in the various weather-changes* upon the European coasts. They show, moreover, the *tracks* which, at each season, Atlantic cyclones are wont to select and pursue as they approach Europe, and the *rates* at which they traverse these tracks. Given these mean data, deducible from the international weather-charts, and the chief elements are had for deciding any special question of weather that arises in the daily work of forecasting. As a late writer says: "The most abstruse discussion of meteorological data have hardly another object than the determination of the average conditions of the climate of each place, and of the amount

of variability which may be anticipated in the march of each element. What is this but forecasting?" Every increase of simultaneous reports is, therefore, another approximation to that knowledge which would, if sufficiently full, enable the European meteorologist to foresee



A "Low Barometer," or Cyclone, crossing the Atlantic from America to Europe. (From "International Weather-Map," February 9, 1878.)

and to give every day more timely forewarning of impending variations in the weather and "the march of each element." But this is the grand end which all such international research contemplates. "From the use of synchronous weather-maps," another prominent English meteorologist tells us, "there has sprung up in recent years a new science of the winds. With the principles of this science all the more reliable rules of weather-forecasting are most intimately connected. We no longer think of judging of coming weather merely by the aspect of the sky and an examination of an individual barometer. We invariably refer—I do not say to the weather-reports of a few hours previous, for we often have neither these nor any weather-reports at all at hand—but *we invariably refer to rules already deduced from the long study of weather-maps.* The man who ignores these rules had better, in my opinion, leave all attempts at weather-forecasting alone. At best his weather-lore will not rise much above that of the bees, which fly to the hive, often to their own detriment, whenever a dark cloud covers the sun." We cite these words as expressive of the wise dependence which the most skillful European meteorologists

put upon the weather-charts of the past. How much more light will they derive from the new international "*simultaneous*" weather-maps! While the scientific world is despairing of finding adequate mechanical means of mooring a floating weather-station in mid-Atlantic to cable its reports to land, the necessity for such a station is being gradually superseded by the development of researches which if studied will supply adequate rules for weather-forecasting without mid-Atlantic reports. The immediate value of every means which offers any approximation to correct storm-warnings for the British and French coasts—frequented by the navies and merchant marines of every flag—is beyond calculation in dollars and cents.

The ultimate value of the temperature and rainfall statistics obtained by this research, especially in their application to agriculture, can not be questioned. Even if such data were of no avail for the general work of weather-forecasting, they reach into the sphere of all farming operations, and are utilized by all classes. One of the most striking exemplifications of this fact has been furnished by Governor Rawson, of the island of Barbadoes, who, in an official paper, has used the rainfall reports "in calculating the probability, or expectation, of coming seasons as respects the yield of the sugar-plantations."

The long-protracted and often torrential precipitation that drenched the British Islands and large portions of western Europe last summer (1879), had been preceded by long-protracted and abnormal chilling of those countries, whose crops were blighted or dwarfed for want of sunshine and ruined by too frequent down-pours. Now, it is a fact worthy of deep reflection that on June 12th, before this dreary and desolating summer had set in, the English journal of science, "Nature," published a summary of thermometric data from ninety-two stations, which demonstrated that "the cold weather, for the six months ending May 1, 1879, exceeded in intensity" (that of) "any other past period of cold weather in these islands of like duration, of which we have an exact and authentic record." Great Britain on the 1st of May was then abnormally refrigerated; these islands, and we may add the adjacent continent, were ready to act as powerful *condensers* of the tropical and North Atlantic vapor wafted over them in enormous volumes by the southwest or "anti-trade" winds, which especially prevailed in summer. But more significant still were the barometric conditions prevailing over Iceland, which so greatly affected the weather of the British Isles. The spring of 1879 was unusually *cold*, and the international weather-charts, prepared by our Signal-Service, show unusually *high* pressures throughout April, 1879, over Iceland, just as occurred in July, 1867, when there was a memorably cold spell in Great Britain —owing to the fact, as Mr. Buchan explains it, that "the pressure being low in Norway and countries surrounding the Baltic, and *high in Iceland*, Scotland was thus placed in the *cold Arctic current* which set in from Iceland toward the Baltic."

Now, with such clear barometric and thermometric conditions in and around Great Britain, a "cold, wet summer" in 1879 was almost inevitable, and a prediction to that effect, based on the simultaneous international data, would have been justifiable. Of course, new conditions might arise late in June, but the conditions prevalent, according to all physical probability, authorized such a forecast at the commencement of the summer, and would have been of incalculable value. Ask the British farmer what he would have freely paid in June to have gained some idea of the July weather! Or ask the English merchant what he would have freely given in June for a tolerably correct crop-forecast for the summer of 1879! Yet this is no hypothetical case, but one familiar to all, involving a whole nation in agricultural and financial distress, against which, with international reports from the Faroe Islands and Iceland, it could have been forewarned.

The collection of the "international" cloud-observations—especially those taken at sea—opens one of the most fertile and fascinating fields, not only for the elucidation of the profoundest atmospheric problems by the theoretical scientist, but for the *popularization* of meteoric knowledge. The clouds are *Nature's weather-guides*, at all times serving to preannounce the approach of storms, or the return of clear weather. Until the middle of the seventeenth century (when Torricelli's experiments led to the invention of the barometer), and long after, the clouds furnished the only weather-indications which the world had. And, the more modern meteorology is developed, the more do the ablest of its leaders seek to understand these unerring monitors of every weather-change. Varied as they are, their forms may be reduced to two or three types, so defined and imposing that the most unscientific can learn to recognize them and construe their meaning. The international observers enter on their blanks the amount and direction of clouds. "The most valuable of weather-signs," says Mr. Ley, "are obtained not so much from the shape of the clouds as from the *directions* from which clouds of different levels are observed to travel, and it is these weather-signs which, in the present state of our knowledge, can be most readily reduced to definite rules."

Take a single illustration of the utility which such rules would have for the farmer, the sailor, or any close observer of the sky. Our storm-centers are generally preceded by a great bank of those clouds to which the name cirro-stratus is given. They are composed largely of freezing or frozen vapor, floating at great elevations, and often very far in front of the depression and over the belt of country which is to receive its rainfall. They move in parallel lines, and are distinguished by their thread-like and attenuated delicacy, as well as by their altitude—from 20,000 to 40,000 feet—from all local clouds. Outlying streaks of the cirro-stratus, frequently visible from twenty to one hundred miles in advance of the main pack, "like pioneers of the coming army," can easily be detected. But the main body, since it forms the

familiar *halo*, can not be overlooked. It is the timely omen of impending disturbance, delivering its faithful warning long before the barometer begins to fall and tell its confirmatory tale. The accompanying cloud-illustrations, constructed, with some variations, after Mr. Ley's designs, will illustrate the chief weather-changes. Fig. 1 represents cirrus and cirro-stratus forming far in front of a cyclone, while yet the barometer has not begun to fall decidedly. Fig. 2 shows the cloud-system attending one of our storm-centers, as viewed from a point say 25,000 feet high (above the disturbance), the whole system borne along in the broad, horizontal "antitrade-wind" belt, from southwest to northeast, the scale of miles 200 to the inch, and the rate of progress fifteen miles an hour.

Could the rural populations and those whose occupation calls them much out of doors be assisted in interpreting these and similar phenomena, however untutored they might be in meteorologic terms and theories, they would soon learn to forecast many of the great weather-changes for themselves. But as the storm-signaling clouds, conspicuous to all, fly aloft in those mighty "upper currents" which, observation shows, attain not uncommonly velocities of one hundred and twenty and sometimes even one hundred and fifty miles an hour, none but *strictly "simultaneous"* weather-reports can adequately or truthfully reflect their actual, ever-flitting movements as related to storm-vortices and other atmospheric phenomena, whose approach and force they foretoken.

Once more. The most popular and profitable use to which meteorologic observations can possibly be put would be, if it is practicable, to *forecasting in part the character of coming seasons*—whether the next winter will be mild or severe, or the approaching summer wet or dry. It is certain that such forecasts will not be made until the network of observing stations is so enlarged as to record the temperature and other conditions over extensive portions of the oceanic, as well as the solid face of the globe. The northern hemisphere at least must be belted with stations returning simultaneous reports before *season-predictions* can be successfully attempted. But, with a broad girdle of observations around the middle latitudes, would it even then be possible to foreshadow the abnormal or extreme heat or cold of a coming summer or winter? It may seem premature to offer any reply to such an interrogatory; and yet it may not be as unanswerable as it seems. It is now pretty clearly ascertained that the earth in its orbital revolution is subjected to very decided periodic planetary influences, which sometimes destroy the balance of the seasons. The researches of Mr. Meldrum and others appear to corroborate the long-suspected physical connection between terrestrial cyclones and those grand solar atmospheric storms which produce or constitute sun-spots. A recent writer, summing up the latest results obtained from these and many like investigations, concludes that "the solar spots and temperatures

Fig. 1.

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HALO
W
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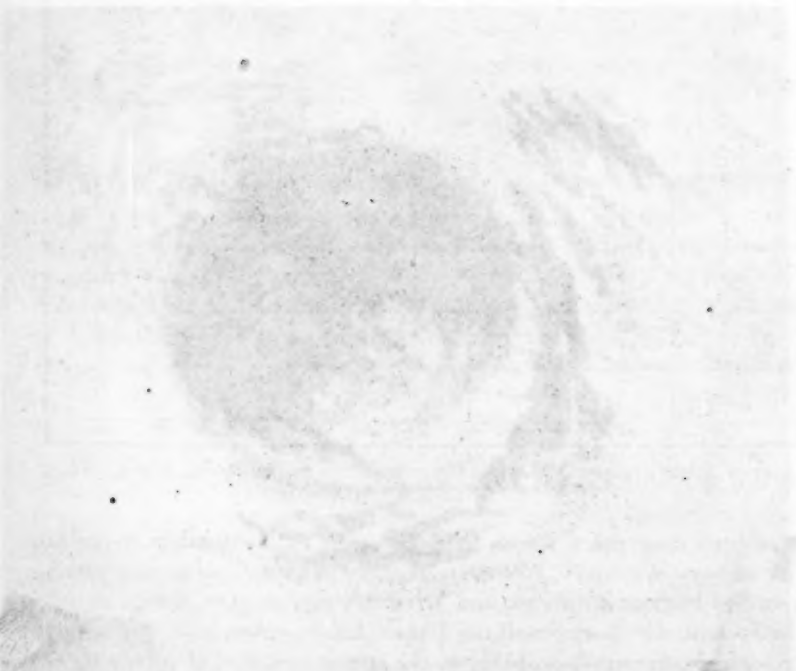
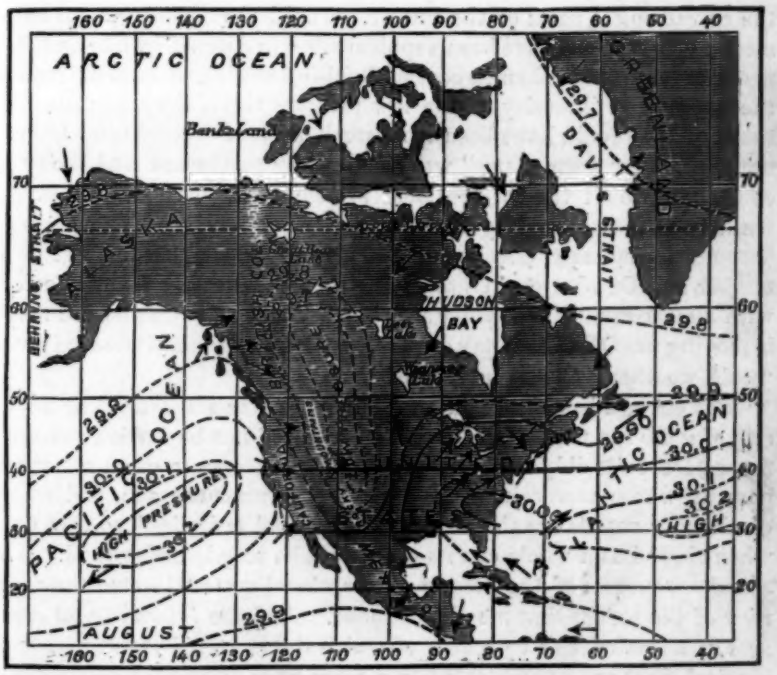
S
DRY & GENERALLY CLEAR
HAZY SKY
CUMULI & SHOWER CLOUDS
STRIPS OF CIRRUS & LOCAL CIRRO-STRATUS

Fig. 2.



change in parallel cycles, and affect every feature in terrestrial meteorology."

But, apart from every aid furnished by cosmic meteorology to that of our individual planet, the extension of the international simultaneous weather-reports will, we believe, ultimately afford the data requisite for approximately forecasting some main features of the seasons. A single example (the great heat of last October on the eastern side of the United States) will illustrate the possibility of attaining in some degree this long-desired object, which, like an *ignis fatuus*, has eluded the pursuit of men for so many ages. The summer of 1879 presented in North America no strongly marked high pressure; but after the 24th of July the barometric conditions were generally "low," and in the "Monthly Weather Review" for August, the Signal-Service stated: "The barometric pressure, as compared with the means of the



(CHART OF EQUAL BAROMETRIC PRESSURES DURING AUGUST, IN AND AROUND NORTH AMERICA. (Arrows show *prevailing winds* for August.)

seven preceding years, shows that *the mean of the entire country has been abnormally low.*" We may compare the atmosphere then resting upon the interior to a vast and fixed *dry cyclone*, the elongated central area of which covered the Upper Lake region, and the country stretching northward, probably to the sixtieth parallel of latitude—the whole extent of the depression not less than 1,500,000 square miles,

and the pressure ranging from 29·90 to 29·70 inches. It has long been known that such a "barometric trough," or stationary depression, forms over the northwestern portion of this continent every summer, when the soil is highly heated by the sun, and the air-strata above it become highly rarefied by terrestrial radiation; Mr. Buchan, on his isobaric charts, assigns to it in July a mean pressure of 29·80 to 29·70 inches. Now, by "the law of the winds," the effect of this barometric depression would be to set up an indraught, somewhat resembling that caused by an ordinary cyclone, around whose center, in our hemisphere, the air draws from right to left, and moves on all sides toward the vacuum. Necessarily, therefore, toward the central belt of this vast continental depression (which during last August covered the interior of our continent up to the Arctic Circle), as into an aërial hollow, the air would flow from the surrounding regions of high pressure, which in that month always lie to the southward in the Gulf of Mexico, and in the extratropical parts of the Pacific. Could the Signal-Service barometric observations have been supplemented in August by like simultaneous observations taken in central British America, so as to determine the extent and intensity of the low pressure there, the anomalous autumn of 1879 could have been in no small measure foreseen and foreannounced. A "warm wave" was then rolling northward and likely to continue. Could the international system of reports have been extended to the upper valley of the Saskatchewan before this enormous barometric anomaly developed, the prevailing weather of last September and October could have been then measurably foreshadowed, with almost as much certainty as, when a "cold wave" from the north is moving over the Lakes any day in January, the Signal-Office indicates "cold weather" for the interior of the country.

But enough has been said on this part of our subject. The necessity of studying the atmosphere as a *unit* need not be further pressed; for, as Dove forcibly said, "it is, as its name shows, a great steam-apparatus, whose reservoir is the ocean, its furnace the sun, and whose condensing vessels are the higher geographical latitudes," so that only when viewed as a whole can its operations be clearly understood. The *simultaneousness* of the present international system insures the accuracy of the results that may be deduced. And the *international chart* acts as a sort of lens by means of which the scattered rays of meteorological light are concentrated in a focus upon the dark points of the science. It is but just to add that the credit of originating, organizing, and elaborating this simultaneous system, both of the ocean meteorology and that of the land, belongs to General Myer, who, in the execution of his plans, has been seconded by the indefatigable labors of his assistants in the Washington Weather Bureau, and sustained by the energetic coöperation of all foreign weather-services.

The extension of this research can not fail to afford the diligent investigator a magnificent view of the complicate and exquisite adapta-

tions of the atmospheric forces. Humboldt records the circumstance that, when, like Balboa on the summit of the Sierra de Quarequa in Darien, he and his companions from the top of the Andes caught their first view of the Pacific Ocean, so great was their joy, they forgot to open their instruments, and every thought was hushed that they might drink in the scene expanding before them. How much more will the meteorologist of the near future, whose mental eye catches a clear glimpse of the Aërial Ocean, mirrored in the modern chart, be lost in admiration, yet constrained to admit with the ancient seer, "Lo! these are but parts of His ways; how little a portion is heard of Him, but the thunder of His power who can understand?"

JOHN STUART MILL.

By ALEXANDER BAIN, LL. D.,
PROFESSOR OF LOGIC IN THE UNIVERSITY OF ABERDEEN.

V.

WHAT I have to say on the ten years from 1848 to 1858 may be conveniently introduced by a reference to the "Autobiography," p. 237. Mill states that, for a considerable time after the publication of the "Political Economy," he published no work of magnitude. He still occasionally wrote in periodicals, and his correspondence with unknown persons on questions of public interest swelled to a considerable amount. He wrote, or commenced, various essays on human and social subjects, and kept a watch on the progress of public events.

The year 1850 was chiefly noted for the first important revision of the "Logic," namely, for the third edition. He had to answer many attacks upon it, including a pamphlet by Whewell. As I was absent from London while this was going on, I had a good many letters from him, chiefly on Whewell's criticism, of the weakness of which he had a very decided opinion. I suggested some alterations and additional examples, but I scarcely remember what they were. The edition was printed in November; and no revision of anything like the same extent was undertaken till the eighth edition came out in 1872.

The "Political Economy" was subject to more frequent revisions, and occupied a good deal of his attention at one time or other, but I did not keep pace with him on that subject.

In the spring of 1851 took place his marriage to Mrs. Taylor. In the autumn of that year I took up my abode in London again, and remained there or in the neighborhood till 1860. I continued to see him

at intervals in the India House, but he had changed his residence, and was not available for four-o'clock walks. He could almost always allow a visitor fifteen or twenty minutes in the course of his official day, and this was the only way he could be seen. He never went into any society except the monthly meetings of the Political Economy Club. On some few occasions a little while after his marriage, Grote and he and I walked together between the India House and his railway-station.

Only three of his reprinted articles belong to the period I am now referring to; but he must have written for the "Westminster Review" at least one or two that were not reprinted. I can not help thinking that the failure of his energy was one chief cause of his comparative inaction. As an instance, I remember, when he first read Ferrier's "Institutes," he said he felt that he could have dashed off an article upon it in the way he did with Bailey's book on "Vision"; and I can not give any reason why he did not.

He wrote for the "Westminster," in 1849, a vindication of the French Revolution of February, 1848, in reply to Lord Brougham and others. In French politics he was thoroughly at home, and up to the fatality of December, 1851, he had a sanguine belief in the political future of France. This article, like his "Armand Carrel," is a piece of French political history, and the replies to Brougham are scathing. I remember well, in his excitement at the Revolution, his saying that the one thought that haunted him was—"Oh, that Carrel were still alive!"

It was for the "Westminster" of October, 1852, that he wrote the article on Whewell's "Moral Philosophy." What effect it had upon Whewell himself I can not say; he took notice of it blandly in a subsequent edition of his "Elements of Morality," in reviewing objectors generally, omitting names. John Grote thought that, in this and in the "Sedgwick" article, Mill indulged in a severity that was unusual in his treatment of opponents. I could not, for my own part, discover the difference. Yet it is no wonder, as he told me once, that he avoided meeting Whewell in person, although he had had opportunities of being introduced to him (I suppose through his old friend Mr. Marshall, of Leeds, whose sister Whewell married).

In 1853 he wrote his final article on Grote's "Greece," in which he enters with enthusiasm into Grote's vindication of the Athenians and their democratic constitution. He was, quite as much as Grote, a Greece-intoxicated man. Twice in his life he traversed the country from end to end. I remember, when I met him at the India House after his first tour, he challenged me to name any historical locality that he had not explored.

In 1854 he had an illness so serious that he mentions it in the "Autobiography." It was an attack in the chest, ending in the partial destruction of one lung. He took the usual remedy of a long

tour, being absent about eight months, in Italy, Sicily, and Greece. I remember Sir James Clark giving a very desponding view of his state; the local disease, however, he said, was not so serious as the general debility, and, in all likelihood, he never would be fit for any other considerable work. According to a remark made to Grote by Peacock, the head of his office, his absence was severely felt at the India House. He rallied, nevertheless, and resumed his usual routine.

In the year following his recovery, 1856, his two seniors in the Examiner's office retired together, and he became head of the office. This made an entire change in his work: instead of preparing dispatches in one department, he had to superintend all the departments. The engrossment of his official time was consequently much greater; and he had often to cut short the visits of friends. In little more than a year after his promotion, in the end of 1857, the extinction of the Company was resolved upon by the Government, and he had to aid the Court of Directors in their unavailing resistance to their doom. For this purpose, he drafted the "Petition to Parliament" in behalf of the Company, in which he brought to bear all his resources in the theory and practice of politics. The petition, as ultimately submitted, after some slight amendments by the Court of Directors, was pronounced by Earl Grey the ablest state-paper he had ever read. I do not mean to advert to its contents, further than to quote the two introductory sentences, the point and pungency of which the greatest orator might be proud of:

"That your petitioners, at their own expense, and by the agency of their own civil and military servants, originally acquired for this country its magnificent empire in the East.

"That the foundations of this empire were laid by your petitioners, at that time neither aided nor controlled by Parliament, at the same period at which a succession of administrations under the control of Parliament were losing to the Crown of Great Britain another great empire on the opposite side of the Atlantic."

Several other documents were prepared by Mill for the Court of Directors, while the abolition of the Company was under discussion in Parliament. It so happened that the Liberal Government, which first resolved on the measure, retired from office before it was carried, and the Government of Lord Derby had to finish it. Under the management of Lord Stanley, as President of the Board of Control, the new India Council was much more assimilated to the constitution of the old Court of Directors; and I am inclined to believe that the modification was in great measure owing to the force of Mill's reasonings.

The passing of the bill led to his retirement from the India House. He told Grote that, but for the dissolution of the Company, he would have continued in the service till he was sixty. An attempt was made to secure him for the new Council. After the chairman, he was the first applied to by Lord Stanley to take office as a Crown nominee. In

declining, he gave, as his reason, failing health; but, had he been stronger, he would have still preferred retirement to working under the new constitution.

His deliverance from official work in 1858 was followed by the crushing calamity of his wife's death. He was then on his way to spend the winter in Italy, but immediately after the event he returned to his home at Blackheath. For some months he saw nobody, but still corresponded actively on matters that interested him. His despondency was frightful. In reply to my condolence, he said: "I have recovered the shock as much as I ever shall. Henceforth, I shall be only a conduit for ideas." Writing to Grote, he descanted passionately on his wife's virtues: "If you had only known all that she was!"

In the beginning of 1859 I was preparing for publication my volume on "The Emotions and the Will." I showed the manuscript to Mill, and he revised it minutely, and jotted a great many suggestions. In two or three instances his remarks bore the impress of his lacerated feelings.

He soon recommenced an active career of publication. The "Liberty" was already written, and, as he tells us, was never to be retouched. His pamphlet on "Parliamentary Reform," written some years previously, was revised and sent to press. On this he remarked in a letter: "Grote, I am afraid, will not like it, on account of the ballot, if not other points. But I attach importance to it, as a sort of revision of the theory of representative government." A few days later he wrote, "Grote knows that I now differ with him on the ballot, and we have discussed it together, with no effect on either."

Of course the pamphlet was well reasoned, but the case against the ballot had not the strength that I should have expected. The main considerations put forward are these two: First, that the electoral vote is a trust, and therefore to be openly exercised; second, that, as a matter of fact, the coercion of the voter by bribery and intimidation has diminished and is diminishing. The argument from "a trust" was not new; it had been repeatedly answered by Grote and by others. The real point at issue was, whether the withdrawing the elector from the legitimate control of public opinion be not a less evil than exposing him to illegitimate influence; and this depends on the state of the facts as to the diminution of such influence. Experience seems to be against Mill on this head; and it is unfortunate for his political sagacity and prescience that the Legislature was converted to the ballot after he had abandoned it.

The "Liberty" appeared about the same time. The work was conceived and planned in 1854. While thinking of it, he told Grote that he was cogitating an essay to point out what things society forbade that it ought not, and what things it left alone that it ought to control. Grote repeated this to me, remarking, "It is all very well

for John Mill to stand up for the removal of social restraints, but as to imposing new ones I feel the greatest apprehensions." I instantly divined what the new restraints would be. The volume must have been the chief occupation of his spare time during the last two years of his official life. It is known that he set great store by the work, and thought it would probably last longer than any of his writings, except perhaps the "Logic."

The old standing question of freedom of thought had been worked up, in a series of striking expositions, by his father, in conjunction with Bentham and the circle of the "Westminster Review"; he himself, from his earliest youth, was embarked in the same cause, and his essays were inferior to none in the power and freshness of the handling. The first part of the "Liberty" is the condensation of all that had been previously done; and, for the present, stands as the chief text-book of freedom of discussion. It works round a central thought, which has had a growing prominence in later years, the necessity of taking account of the *negative* to every positive affirmation; of laying down, side by side with every proposition, the *counter-proposition.* Following this cue, Mill's first assumption is, that an opinion authoritatively suppressed may possibly be true; and the thirty pages devoted to this position show a combination of reasoning and eloquence that has never been surpassed, if equaled, in the cause of intellectual freedom. The second assumption is that an opinion is false. Here his argument takes the more exclusive form of showing the necessity of keeping in the view the opposite of every opinion, in order to maintain the living force of the opinion itself. While there is much that is effective here also, I think that he puts too great stress upon the operation of negative criticism in keeping alive the understanding of a doctrine. It is perfectly true that, when an opinion is actively opposed, its defenders are put on the *qui vive* in its defense, and have, in consequence, a far more lively sense of its truth, as well as a juster view of its meaning and import; but the necessity of keeping up imaginary opponents to every truth in science may easily be exaggerated. We need not conjure up opponents to gravitation so long as a hundred observations and a hundred thousand ships are constantly at work testing its consequences. This is the substitute that Mill desiderates (page 80) for the disadvantage of the cessation of controversy in truths of great magnitude.

When he proceeds to illustrate the enlivening influence of negation by the case of ethical and religious doctrines, I think he fails to make out his case. It may be true enough that, when a creed is first fighting for reception, it is at the height of its fervor, but the loss of power at a later stage is due to other causes than the absence of opponents. Mill's illustration from Christianity is hardly in point. Never since the suppression of pagan philosophy was Christianity more attacked than now; but we can not say that the attacks have led, or are likely to

lead, to a resuscitation of its spirit in the minds of Christians: the opposite would be nearer the truth.

The last branch of the argument for free thought is constituted by Mill's favorite doctrine that conflicting doctrines usually share the truth between them. This view is, I think, both precarious in itself, and of very doubtful relevance to the author's main thesis. The example from the two state parties—the party of order and the party of progress—will not stand a severe scrutiny. Not to mention, what he admits, that there is perfect freedom of discussion on the matter, the war of parties is, in point of fact, scarcely conducted according to his ideal. More to the point is the well-known passage on Christian morality, which he regards as a series of half-truths, needing to be made up by truths derived from other sources. As far as his main purpose is concerned, I think all this belongs to the first branch of the argument, and might have been included there: that first branch containing, to my mind, the real strength of the contention for freedom of thought.

The second half of the book is on liberty of conduct, as against the restraints of our social customs. This is introduced by a chapter on individuality, considered as one of the elements of well-being. Excellent as are many of the author's remarks, there are various openings for criticism. The chief thing that strikes me is the want of a steady view of the essentials of human happiness. I shall have to notice again the defects of Mill's Hedonic philosophy. I think that he greatly exaggerates the differences between human beings as regards the conditions of happiness. The community of structure in our corporeal and mental framework far exceeds the disparities: there are certain easily stated requisites, in the possession of which no one could be very unhappy; while the specialties needed to impart to a given individual the highest degree of felicity are seldomer withheld by the tyranny of custom than by causes that society can not control. Mill pleads strongly for the energetic natures, for the exuberance of spontaneity and strong impulses. But energy as such is not thwarted; and the difficulty will always remain, that superabundant energy is exceedingly apt to trench upon other people's rights. Mill too closely identifies energy with originality or genius, and genius with eccentricity. In regard to all these characteristics, many fine distinctions need to be drawn, over and above what Mill gives us. When he talks of the present state of Englishmen as a state of collective greatness and diminishing individuality, it takes a little reflection to see what he is driving at. Nor is his reference of the unprogressiveness of the East to the despotism of custom a wholly satisfactory explanation; the problem of stationary societies is still undecided.

The chapter following, entitled "The Limits to the Authority of Society over the Individual," helps us better to his real meaning. He lays it down as an axiom that society should interfere only in what

concerns itself. One might suppose that this would have passed as an axiom, instead of being caviled at on all hands. Why should society, more than any other entity, interfere with what does not concern it? Even accepting the axiom, we may yet work it in society's favor by those numerous pretexts whereby individual action is alleged to have social bearings; but to refuse the axiom itself argues some defect of intelligent comprehension.

As a piece of vigorous composition, this chapter is not inferior to any in the book; it is admirable as an exposition in practical ethics, and might be enshrined as a standing homily in the moral instruction of mankind. It does what homilies rarely do, namely, endeavor to draw precise lines between social duty and individual liberty; and reviews the more notable instances where society still tyrannizes over minorities. Still, the instances adduced seem scarcely to justify the denunciations of the author; they are the remains of past ages of intolerance, and are gradually losing their hold.

It is in his subsequent chapter of "Applications" that we seem to approach his strongest case—but it is little more than hinted at—I mean the relationship of the sexes. It hardly admits of question that any great augmentation of human happiness that may be achieved in the future must proceed first upon a better standard of worldly circumstances, and next upon the harmonizing and adjusting of the social relations. After people are fed, clothed, and housed, at a reasonable expenditure of labor, their next thing is to seek scope for their affections; it is at this point that there occur the greatest successes and the greatest failures in happy living. The marriage relation is the most critical of any; and we have now a class of thinkers that maintain that this is enforced with too great stringency and monotony. To attain some additional latitude in this respect is an object that Mill, in common with his father, considered very desirable. Both were strongly averse to encouraging mere sensuality; they were not prepared with any definite scheme of sexual reform; they merely urged that personal freedom should be extended in this respect, with a view to such social experiments as might lead to the better fulfillment of the great ideal that the sexual relation has in view.

The "Liberty" was exposed to a good deal of carping in consequence of Mill's admitting unequivocally that a certain amount of disapproval was proper and inevitable toward persons that behaved badly to themselves. It was said, What is this, after all, but a milder form of punishing them for what does not concern either us or society at large? He fully anticipated such a remark, and I think amply disposed of it, by drawing the very wide distinction between mere lowered estimation and the treatment proper to offenders against society. He might have gone further, and drawn up a sliding scale or graduated table of modes of behavior, from the most intense individual preference at the one end to the severest reprobation at the other. At least

fifteen or twenty perceptible distinctions could be made, and a place found for every degree of merit and demerit. Because a person does not stand high in our esteem, it does not follow that we are punishing or persecuting him; the point when punishment in any proper sense could be said to begin would be about the middle of the scale. Mill remarks justly: "If any one displeases us, we may express our distaste and stand aloof from such an one; but we shall not therefore feel called on to make his life uncomfortable," still less to send him to prison or to the stake.

A ROGUISH HOUSEHOLD PET.

By FRANK BUCKLAND.

AS company for the monkeys and myself, for many years past, I have had a "Jemmy." All my Suricates I call "Jemmys." The Latin name is *Suricata Zenick*. Jemmy is a very pretty little beast, somewhat like a small mongoose or very large rat. His head is as like the head of a hedgehog as can be imagined. His color is light brown, with darker stripe down the sides. He is an African animal, and lives in burrows on the plains, whence he is sometimes called the African prairie-dog, or the *meercatze*. Captain Adams tells me that, when in South Africa, he has frequently come across a camp of Jemmys. The plain will appear covered with them, sitting up motionless like so many ninepins; at the least notice, they simultaneously and in an instant disappear down their holes.

SURICATE (*Suricata Zenick*).

I would like now to say something of the habits of this pretty little fellow, which was kindly given to me by Mr. Forbes Nixon. Jemmy the Third (for I have previously had two Jemmys) was allowed the free range of the whole house. He was full of curiosity and restless-

ness, running continually from one room to another. He very seldom walked; his pace, on the contrary, was a short gallop, or rather canter. When on the move he always gave tongue, like a hound on a scent. It is impossible to describe his melodious cry in words. When handled and petted he would utter a sharp bark, not unlike that of a dog; and, if in a very good humor, I could, by imitating him, make him bark alternately with myself. His great peculiarity was his wonderfully intelligent and observing look. He had the peculiarity also of sitting up on his tail, like a kangaroo; his fore-paws on this occasion were like a dog's when begging. He was very fond of warmth, and would sit up inside the fender and warm himself, occasionally leaning back against the fender and looking round with the satisfied air of an old gentleman reposing after dinner. When the morning sun came into the room, Jemmy would go and sit in the sunbeams and look out of the window at the passing cabs and omnibuses. When doing this he had a way of turning round very sharply, and looking with his little pig's eyes at me and back, as much as to say, "What do you think of that?" When breakfast came up he would dance round me on his hind-legs, watching for something. I often put him on the breakfast-table; if I did not put him up he would climb up uninvited. It was very amusing to see him go and smell the egg, and, in his own language, swear at it for being hot. He could not understand its being hot enough to burn his nose; raw eggs were his special favorites. His great delight was to be allowed to upset the sugar-basin, and then scratch about among the lumps of sugar. He was also very fond of cream, and it was most amusing to see him try to get the little drops of cream I had left for him out of the cream-can, as left by the milk-woman. I am obliged to have my cream in this little can, as the cats, marmoset, or something else would be sure to have it before I came down. I placed the cream-can on the floor, and it was fun to see Jemmy try to force it open with his teeth, to get the cream out; he used quite to lose his patience with this metal cream-can.

After breakfast, Jemmy generally had a stand-up fight with the monkeys. He would inspect (from the outside) the bottom of the monkey-cage. If he discovered any portion of the monkeys' breakfast which he thought might suit him, he would immediately try to steal it by thrusting his arms through the bar. The monkeys invariably resented this indignity. The carroty, old, crippled monkey, Jane, could only make eyes and faces at him. The wicked, impudent "Little Jack" would jump up and down like an India-rubber ball, all the time well inside the cage, where Jemmy could not get at him. When Jemmy was fighting the monkeys, he would stand on his hind-legs and show his lovely white, carnivorous teeth at them, turning up his sharp, mole-like nose in a most contemptuous manner, all the time keeping up a continuous bark, into which fun the parrot generally entered and barked like Jemmy also.

One morning, in the middle of the fight, Jemmy forgot himself for the moment in turning round, and gave the ever-vigilant Little Jack a chance. Little Jack seized Jemmy's tail with screams of delight, and pulled him straight up to the bars. Carroty Jane then joined in, and they were getting the best of it, when suddenly Jemmy turned sharp round and made his teeth meet in Little Jack's hand. Little Jack skirmished round the cage three or four times on three legs; then, holding up his wounded hand, gazed mournfully and piteously at it, every now and then leaving off looking to make fiercer faces, and cock his ears at Jemmy. Never since has Little Jack ventured his hands outside the bars when a Jemmy-fight came on.

One of the funniest scenes that ever happened with Jemmy was as follows: Some seaside specimens had been sent me, and among the seaweed was a live shore-crab about the size of a five-shilling piece. Little "Chick-Chick," the marmoset, who will eat any quantity of meal-worms, blue-bottle flies, etc., came down at once off the mantel-piece and examined Mr. Crab, who was crawling about on the floor. None of my animals had evidently seen a live crab before. The monkeys were very much frightened, and made the same cry of alarm as when I show them a snake or the house-broom. Chick-Chick evidently thought that the crab was a huge insect. The crab put out his two nippers at full length, and gave the marmoset such a pinch that he retreated to the mantel-piece, and from this safe height gazed down upon the still threatening crab, uttering loud cries of "Chick, chick, chick!" alternated with his plaintive, bat-like, shrill note. Presently round the corner comes Mrs. Cat. The cat evidently thought that the crab, which was gently crawling about, was a mouse. She instantly crouched, head, eyes, and ears all intent, as if trying to make up her mind whether the crab was a mouse on which she ought to pounce or not. Hearing the row caused by the crab and marmoset fight, up comes Jemmy in full cry, with tail cocked well in the air. He also attacked the crab, but could not make head or tail of him. He did not like the smell, still less did he like the sundry nips in the nose that he received from the crab's claws. Jemmy has teeth half carnivorous, half insectivorous. When he is at home in Africa he lives upon mice, beetles, etc. He probably digs these creatures out of the ground, for, whenever he sees a crack in the floor, or a hole in a board, he will scratch away at it, as though much depended upon his exertions. When he is fed, it is curious to observe how he always pretends to kill his food before eating it. He invariably retreats backward while he is scratching and biting at his supposed lively food. The living food evidently is in the habit of escaping forward. Mr. Jemmy takes good care that he shall not do so, by scratching incessantly in a backward direction. A grand crab and Jemmy fight, which lasted nearly half an hour, then took place, ending in the discomfiture of the crab, whose carcass the marmoset and the cat, both coming for-

ward, evidently desired to share. Although it was apparent that the taste of the crab was not agreeable to Jemmy's palate, yet he gradually ate him up, claws, shells, and all, simply to prevent the other animals from getting a single bit.

The cat's-meat man comes punctually every day at half-past one; when the cats hear the cry "meat," they rush down into the area, and Master Jemmy, seeing them bolt, would run also, his object being to steal the ration of meat from one of the cats. By instinct or experience he had somehow found out that the cat's claws are very sharp, and whereas his mode of attack upon the monkey was face to face, the monkeys being clawless, he attacked the cats by ruffing his hair up and pushing himself backward.

The cat, annoyed by being disturbed at dinner, would leave off eating and strike sharply at Jemmy with her paw; that was his opportunity. In a moment he would seize the cat's-meat and bolt with it, but by a most peculiar method, for when within striking distance of the cat's paw he would turn round and back up to the cat's face, and, directly she struck at him, he caught the blow on the back, then he would put his nose down through his forelegs, and through the hinder ones, and have the meat in a moment, leaving the cat wondering where it was gone. Jemmy had by this time taken it into a place of safety. Under the table in Mr. Searle's office there is just room for him to crawl; here the angry cat could not of course follow him. In this retreat he would finish up what he had stolen, and then emerge, licking his lips, and probably laughing to himself at the disappointed face of the cat. Jemmy was always fond of getting under anything or in any kind of hole, and his great delight was to get into a boot, and when he got to the end scratching it as though he wanted to get farther into the burrow. Frequently I found my boots going round the room, propelled, apparently, by some internal machinery. This machinery was Master Jemmy.

Jemmy was a greedy little fellow. John could not bring up any kind of food into my room without Jemmy. He would watch the cook broiling the chop down stairs, and when John brought it up would follow close to his heels, and what between Jemmy's pretty, begging manner, the monkey's plaintive cries, and the parrot's demand, it often happens that I get very little of the chop.

I had hoped to have written a fuller biography of our poor little Jemmy the Third, but alas! on Sunday last Jemmy was taken with a fit. I did everything I could to relieve the poor little fellow, but the fits were too much for him, and Mr. Searle and myself have been busily occupied in making his skin into a mat and his bones into a skeleton. The last Jemmy died of eating cotton-wool; this Jemmy died, I think, of eating too much, for he was as fat as a little bacon-pig, and weighed two pounds—a great weight for such a little animal. It is curious how fond I become of dear little animals

such as Jemmy, and how much I miss his pretty little ways as I sit in the "Monkey-room" writing this memoir of my little pet.—*Land and Water.*

ON THE MIGRATIONS OF RACES.*

By FRIEDRICH MÜLLER.

IN endeavoring to subject this question to a brief examination, it must be previously understood that we only refer to those migrations which explain the distribution of existing and contemporaneous races and peoples, and such as can be deduced with some certainty from acknowledged facts. Neither will we consider migrations of individual races from some hypothetical ethnic center, nor those which many tribes have made that at present no longer exist. Except the aborigines of Australia, every people has undertaken migrations of greater or less extent, and many weighty reasons can be given to explain why the Australian has not ventured outside of his primitive abode. In the first place, from the very character of his country, through the absence of those animals and plants which contribute to enjoyment and prosperity, he had not raised himself to a knowledge of the pleasures of living incident to an advancing culture; and, in the second place, the country was itself large enough to contain the limited number of inhabitants, and to satisfy their simple wants. Whether the immediate neighbors of the Australian—the Papuans—have ever undertaken migrations is questionable; on account of the circumstance that they universally inhabit islands, and their dwellings built along the coasts resemble the pile-villages discovered in central Europe, it is easier to say they did migrate than to deny it. Yet the whole question is most intimately united to another, viz., Shall we consider that the ancient continent, of which the islands of the Indian Archipelago are fragments, was already peopled before its submergence, or were these separate islands successively occupied by expansion from some center?

None of the known races has undertaken so extended a migration as the Malayan. The distribution of this race from Madagascar in the west to Easter Island in the east, and from the Sandwich Islands in the north to New Zealand in the south, illustrates this. Notwithstanding its extent, this dispersion is traced from an ascertained point to the several islands as the traditions of each and the related character of the idioms of the individual branches unanswerably demonstrate.

Africa shelters at present five races distinct from one another, viz., the Hottentot in the extreme south and southwest, the Caffre, spread northward from the Hottentot, as far as and beyond the equator,

* Translated from the "Allgemeine Ethnographie," by L. P. Gratacap.

the negro races in the so-called Soudan, the Fellahs inclosed between the negroes and reaching from east to west in a straight line, and the central races spread from the north and northeast to the equator.

Of these five races, the first four only can be regarded as autochthonous, while the last, comprising well-established groups, migrated from Asia.

The Hottentots were formerly the exclusive inhabitants of southeasterly parts of Africa, from the Cape up to 18° or 19° south latitude. They were driven from their settlements by the invading Caffres streaming from the north, and at first were pressed back into the most southerly regions, and then later from this extremity northward along the west coast until they fixed themselves in the districts they now occupy. The northern neighbors of the Hottentots, the Caffres, are not aboriginal in the southern country, where at present they most numerously exist, but have immigrated here. They settled originally farther north, and stood in close relations for a long period with the Hamitic peoples, which migrated from Asia, as is clearly shown by their idioms. Since by reason of their type and intimate relationship they could not, for any length of time, have been separated by their primitive languages, which were continually approximating, they may have formed an individual group at the time of the invasion of the Hamites from the north into Africa; but they exhibit, in fact, so close points of resemblance with the Hamitic idioms that, without attributing this to direct contact, the coincidence appears inexplicable. Besides this *drift* from the north to the south, which is established from already ascertained facts, another from east to west diagonally across the continent was later instituted. From this circumstance it happens that the language of many stocks in the extreme northwest of the Caffre area show the most intimate relationship with those of the extreme northeast—a relationship not to be accounted for by a reference of both to the primitive tongue common to the Caffre or Bantu tribes, but completely through derivation from a branch of this original speech.

That the Fellah races are not aboriginal in those regions which they at present occupy is proved by their distribution among the negro races. Such a stratification of two races can not be aboriginal, but indicates distinct migrations of each. According to our view, the Fellah originally settled north of the negroes, probably in the territory now possessed by the Berbers, and pressed from the northwest into the land occupied by them, whence they spread toward the east to Nubia. This opinion is confirmed by the close relationship of the Fellah races with the central tribes, which appears to demonstrate an intermixture, as also by the many points of resemblance which the Fellah idioms offer to the Hamitic tongue.

That the individual peoples into which the negro race is divided have undertaken many migrations is at the very outset established by

the great number of stocks, which are linguistically distinct, and of which only a few show any relationship with each other. Slavery may have contributed not a little to assist this dispersion, as that institution is by no means an invention of white men, but was long practiced by the blacks among themselves. It is not infrequent to see many negro tribes experience, through expulsion from their home, the same fate which among us overtook the Jews and Armenians.

These migrations of the four aboriginal races of Africa were not voluntary, but were pursued under the pressure of external circumstances. It certainly was owing to the immigration *en masse* of the central races, and especially the Hamitic stock, that compelled the aborigines of Africa to recede before their mentally and bodily superior invaders, and withdraw to the south of the continent. The inception of these emigrations is of great antiquity, and may be approximately described as follows:

The Egyptians were the last of the immigrated Hamitic stock, as we find them located immediately on the boundary of Suez, over which arm of land the migrations found their path. The accepted history of the Egyptians goes back four thousand years before Christ, at which time they had already erected a monarchical unit based on a highly developed culture. After allowing the shortest possible time for the Egyptians to have developed their culture from the rude beginnings to that height which is noticed in their monuments, viz., one thousand years, we find the year 5000 B. C. the latest date for their entry into Africa. Now, before the Egyptians, their relatives, the Berbers, with their collateral branch, the extinct Guanches, the Bedsha, the Somali, the Dankali, the Galla, and other tribes, wandered into Africa, and as ethnic movements are customarily slow and successional in nature, we may take one thousand years for the migration period. Thus at the lowest reckoning we reach the year 6000 B. C., from which we can date the movements of the autochthonous races of Africa.

As to the New World, according to our own view and that of other inquirers, at least two distinct races are represented, viz., the Esquimau in the extreme north, and the Indian distributed from the settlements of the Esquimau down to the extreme south. Other students take the ground that the type which we have named the Indian should be split up into many races, how many is not agreed. Whatever the facts in regard to this, all agree that the Esquimau is to be sharply separated from the Indian, and that he is not autochthonous in the New World, but a recent immigrant from the extreme north of Asia.

Among the Indian races, of whom only a few can be united linguistically in groups — as in respect to language the same heterogeneity prevails in America as among the negroes of Africa — still further migrations have been undertaken. These can easily be traced to their objective points. In North America such a point is the

fruitful table-land of Mexico, toward which that stem, which in the north had attained among its kindred to a higher culture and greater strength, directed its victorious march. We find here many succeeding peoples of whom it is as yet not clearly shown whether they were fundamentally distinct, or in some particulars structurally related. The last of these invaders, the Aztecs, came from the north, and, as the language proves, are represented there to-day. According to the most recent investigations, the gigantic mounds which are found in North America are to be attributed to a people nearly related to the Aztecs of Mexico, and represent the rude precursors of the colossal structures of Central America. At any rate we must recognize in the northern division of the American Continent an *ethnic drift* whose direction was from north to south.

As to South America, the plateaux of Peru formed the destination of the migrations, as did Mexico in North America. Here also we encounter successive peoples, the last of whom—the conquering Incas—were found by the Spaniards on the discovery of Peru. Like the Aztecs in Mexico, the Quichuas were in no respect the originators of the indigenous culture, but have appropriated the same from a nation which preceded them. Although it is not improbable that the civilization of Mexico and Peru is at bottom congenital, as old elements of civilization could have been transported over the isthmus and on either side independently developed—in such a case the Muisca of Colombia might have formed the intermediate link—yet it is certain that the Mexicans and Peruvians were isolated, and as in the Old World with China and the rest of Asia, the one had no positive knowledge of the civilization of the other.

In regard to the two continents of Europe and Asia, which in fact form but one, inasmuch as the separation by the chain of mountains lying between them could not serve as an isolating boundary, we recognize, apart from the early Malayan, four autochthonous races, viz. : the Hyperboreans in the extreme north, stretching along the borders of the Arctic Sea ; the Dravida race, in southern India ; the Upper Asiatic race, filling central and eastern Asia ; and, finally, the midland races, which at present occupy the south of Asia from India westward, the northeast and north of Africa, and, with the exception of the extreme north and some spots in the middle and south, all Europe.

The Hyperborean race was formerly much more imposing than it is at present, reduced as it is to an insignificant remnant. They formerly settled farther south, and were pushed to the extreme north by the expanding Upper Asiatic race. The circumstance of finding in central Asia representatives of this race, though to be sure deprived in large measure of their national characteristics, confirms this. We refer to the Yenisei Ostiaks, together with other small stems which are philologically diverse from the Ural Altaïans, and presumably are allied to the Yukagiren, Koriaks, Tchuktchis, and Ainos.

The Dravida race once possessed all India from Cape Comorin to the Himalayas, and spread also across the Indus out to Beloochistan. Invaded by the immigrating Aryans, they were forced southward, until finally they contracted their limits within the southern half of the Indian Peninsula, the so-called Deccan.

That this race formerly reached so far northward as we have indicated is proved by the Brahuis in Beloochistan, whose existence in this country can only be accounted for by such an hypothesis. The beginning of the migrations of the Dravida race coincides with the appearance of the Aryan in the Punjaub and may be placed somewhere about the year 2000 B. C.

Central Asia must be considered the early home of the so-called Mongolian, more properly Upper Asiatic race. From this point this race radiated in all directions, but predominantly to the east and south. The leading people of this race, the Chinese, according to ancient traditions, came from the west into the great valleys of the Hoang-ho and Yang-tse-Kiang. But before them this region was already occupied by another people, as their vestiges, seen in the so-called Miao-tse, demonstrate. This stem is not, as we know now, a member of a distinct race, but only of a separate people, and is allied to the people of upper India, especially to the Thai. Thus, before the migration of the Chinese, itself hidden in a gray antiquity, there took place another migration of the aborigines of China belonging to this same race.

The inhabitants of Japan are also not autochthonous, but have immigrated from the west. They found on their settlement here natives who were, in their physical features, very distinct from the intruders. Indeed, the fact that in the southern districts the color of the skin of the inhabitants is dark, and their hair somewhat curly, points to a mixture with a darker race. It is not improbable that the Papuan race, whose existence on the Philippine Islands, and perhaps also on Formosa, has been established, diffused themselves originally as far as Japan.

The migration of the Upper Asiatic race to the west must have begun early, as we already find in the far past the Lapps and Finns in northern and northeastern Europe, peoples belonging to this race. It is not improbable that this race before the entrance of the Celts into Europe occupied the entire north and northeast, and possibly also a great part of central Europe. Many writers consider the people who used unpolished stone implements and weapons, found in northern and middle Europe, as being a branch of the Mongolian race.

Hence Europe may have been inhabited by only two races before the entrance of the Indo-Europeans, which latter is coincident with the appearance of the Etruscans and Celts, viz., by the Basques and Ligurians—a people of unknown ethnological character in the south, and the Upper Asiatic stems in the north. This settlement of the Upper Asiatic race in Europe, long before the immigration of the Indo-Euro-

peans, presumes a migration of the former in the earliest dawn of antiquity.

In our opinion, it was this race which first gave the migratory impulse to the men inhabiting the Old World. The members of this race are well known to be almost exclusively nomads, whose support is derived from the abundance of their herds and the fertility of their pastures. It would only need one bad year, or a plague among their flocks, to constrain these powerful hordes to invade the territory of their neighbors and expel them from their lands. These latter were compelled in a similar manner to press upon *their* neighbors, whereupon the various tribes were set in motion upon every side.

If we regard the Indo-Europeans as neighbors of the Upper Asiatics, and the Semitic and Hamitic peoples next to them, we can understand how in consequence of a pressure of the Upper Asiatics on the Indo-Europeans these must again impinge upon the Semitic and Hamitic race. Whereas the latter were pushed toward Africa, where they imparted their migratory motion to the autochthonous races, as described above, the Semitic pressed into the seats occupied before by the Hamites, and allowed the Indo-Europeans room to expand unhindered east and west. Thus they in turn urged the Dravidas on one side into India, and on the other various tribes into Europe, compelling those migrations which we have briefly sketched above.

After this first migration of the Upper Asiatic races, which occurred before the commencement of the civilizations of China and Egypt, we encounter a second which originated those commonly known ethnic movements which can be more closely followed, as they fall within the historic period.

In consequence of this migration, the Hungarians and Osmanli reached the grounds occupied by them, and there was caused, through the entrance of the Germanic and Slavic peoples into the heart of Europe, that intermixture in consequence of which the Roman people arose, and the various Germanic and Slavic tribes attained their marked individuality.

As to the last of the races, the central or midland, it appears that their primitive seats should be looked for in the Armenian highlands. The migration from this center of the four branches of this race, viz., the Basques, the so-called Caucasians, the Hamito-Semites, and the Indo-Europeans, can thus be easily understood, though the displacement of this original seat farther east would certainly make the distribution of the Indo-Europeans, if not that of the other three, more comprehensible.

From the midland tribes the Basques first separated, turning toward the west, to Europe; the Caucasians followed, and their hordes, pushing to the north, found in the mountains of Caucasus a barrier which permitted them to extend their limits but slowly. The two remaining clans, viz., the Hamito-Semitic and Indo-Europeans, were

for a considerable period neighbors, which is confirmed by the intimate correspondence of their religious and tribal traditions, so that, even after a separation, the Hamites and Semites yet formed an indissoluble unit. Their identity continued during the period of speech-growth, and was first lost when, through the pressure of the Upper Asiatic bands, the Hamites were sundered from the Semites, and were pushed on one side into the region bordering the Tigris and Euphrates, and on the other into Africa.

As we have already considered the immigration of the Hamites into the north of Africa in reviewing the peoples of this continent, there only remain to be examined the Semitic and Indo-European stocks.

Everywhere where the Semites appear we find them successors of the Hamites. It is so in Mesopotamia, in Palestine, in north Africa, presumably in Arabia, as it would seem from the dialects retained in south Arabia, entirely distinct from the Arabian tongue, and, lastly, in Abyssinia, a settlement effected from southwestern Arabia and across the Red Sea. In most places the Hamitic cultus disappears, ethnologically speaking, in that of the Semites, only leaving traces of its influence behind in the national characteristics. So in Mesopotamia, in Palestine—the Phœnicians are, for instance, Semiticized Hamites—in Abyssinia. And only when we know that the inhabitants of Mesopotamia are Semiticized Hamites is the harmony or coincidence of the Assyrian-Babylonian culture (Semitic) with that of the Egyptian (Hamitic) explained.

As regards the Indo-Europeans, we have first sought their aboriginal center about the sources of the Oxus and the Jaxartes, on the tablelands of Pamir, presumably because this point is nearest to the homes of two of the most easterly removed branches of this stock, viz., the Iranians and the Indians, and both these people certainly entered their territory from the northwest and northeast. But of late it has not unreasonably been insisted that the vocabulary of the Indo-European affords no evidence which intimates an acquaintance with the fauna and flora of Asia. On the contrary, the names of most trees known to all the Indo-European peoples, as birch, beech, oak, point rather to eastern Europe than to Asia. Therefore many authorities incline to locate the primitive home of the Indo-Europeans, or that point where they last composed an homogeneous unit, in the Lithuanian-Russian plains, or even farther west.

When, in conformity with this view, which has a very strong likelihood in its favor, we assume the original center of the Indo-Europeans to have been in southeastern Europe, then we can not but regard them as autochthonous at this point, yet as having first reached here from the Armenian highlands in the indefinite past. We are driven to this hypothesis by the racial unity of the Indo-Europeans with the Hamito-Semitic and Caucasian stocks, for it is impossible for both to have emigrated from the west into the highlands overlying Mesopotamia.

As is known, the Indo-Europeans are subdivided into eight groups, viz., Indians, Iranians, Thracian-Illyrians—whose fragments may be identified with the modern Arnauts, Albanians, or Skipetars—Greeks, Italians, Celts, Slaves, and Germans; which, again, according as they were earlier or later sundered from the common tree, or have among each other formed a single society a longer or shorter time, separate into subordinate groups. A. Schleicher, who has with especial assiduity pursued this inquiry, conceives in the first place that the Indo-Europeans split into two groups, viz., Germanians and Slaves on one side, and Aryans (Indians or Iranians), Greeks, Italians, and Celts on the other, whereby the Thracian-Illyrians are numbered among the Greeks. Later, on one side, the Germans divided from the Slaves, on the other the Aryans from the remaining three stems, and then that group in the same way disintegrated.

Many weighty considerations oppose this view of Schleicher's, and we shall permit ourselves briefly to explain our theory, which rests upon a careful examination of these very facts. According to our view, the Thracian-Illyrians first broke away from the common stock and withdrew southward, where they took possession of the Balkan Peninsula and the coasts along Italy. Later the original body split into two parts, viz., on one side the Celts, Italians, and Greeks, on the other Aryans, Slaves, and Germans. Thereupon the Celts separated from the first group, going westward, while the Italians and Greeks yet remained together for some time; in the same way the Germans separated from the Aryans and Slaves, turning northward. Finally the Italians parted from the Greeks, and the Slaves from the Aryans, which on their side again divided into Iranians and Indians. But, in spite of this concentric diffusion, many nations maintained an intimate union, as the Italians and Greeks, the Iranians and Indians, the Slaves and the Germans, whereby many points of contact in the social habits of these peoples were instituted. These resemblances, secured after the primal separation, are not to be confounded with the fundamental features held in common and extending back anterior to their subdivisions.

After this briefly outlined family tree of the Indo-Europeans, the peoples embraced therein undertook important migrations. There was an easterly migration of the Iranians, to whom belong the modern Persians, Kurds, Ossets, Armenians, Beloochees, and Afghans, and among whom in ancient times most of the peoples in Asia Minor were numbered, as the Phrygians, Cappadocians, and the Indians who at present occupy the peninsula of India from the north to the Deccan, with the exception of the territory in the mountainous interior. Far west and southwest the Celts first spread, when they came upon the Basques and Ligurians and ousted them; later came the Italians, spreading themselves from their peninsula outward, through the triumphs of Roman arms, over the whole of southwest Europe, invading the Celts;

and finally appear the Germans and Slaves, the two mightiest peoples of to-day.

In conjunction with these migrations of races, widely extended wanderings are apparent among the related divisions of the central or midland races, and especially of the Semites and Indo-Europeans, which wanderings are conjoined with the sad fate of the peoples concerned.

The fate of the Jews is well known, at present scattered over the whole world as traders and bankers. The Phœnicians played the same *rôle* in antiquity as the Jews in modern times; we find them everywhere at that time, wherever the country was open to commerce. The Armenians, among the Indo-Europeans, may be compared with the Semitic Jews. The migrations of the Armenians, who like the Jews have no particular fatherland and in great measure live by traffic, are in no way behind those of the Jews; besides, the history of both people has a great resemblance, as in large part their movements have been the result of religious persecution.

A people who have migrated widely are the notorious gypsies. According to their descent, the gypsies, who call themselves Roman, are Indian. They speak an idiom which finds a relative in the present dialect of India—the Enkelinnen of the noble Veda tongue. Indeed, there is impressed on this idiom a mixture of foreign elements from all the tongues of Asia and Europe, through whose areas the fugitives passed. We find in it Persian, Armenian, Greek, Magyar, Slavonic, German, and Roman terms, and increasingly as we follow the jargon westward. In every country that the gypsy has reached, he has picked up morsels and incorporated them in his own idioms. But these very philological fragments are of the greatest value to the student, as they surely indicate to him the road which the fugitive from the far East has pursued in his migration.

VACCINATION IN NEW YORK.

By R. OSGOOD MASON, M. D.

THE question of the usefulness and safety of vaccination as practiced in the principal cities of the United States is fairly settled. The general voice pronounces it both safe and useful. A small minority only of the intelligent refuse to acquiesce in the verdict, and comparatively few among the ignorant now refuse to test its benefits. In Europe, notably in England and Germany, the same can not be said. It is among the German population that even here the greatest prejudice exists, and in England there is at the present time a controversy going on, growing out of efforts to extend and enforce a compulsory

vaccination law, which opens up all the old issues and affords opportunity for sending broadcast statements of the most sensational and mischievous character. These have recently been collected by a well-known *littérateur* and forwarded as a newspaper letter to this country, where, on account of their startling and sensational character, they have been somewhat widely copied.

It is charged in these statements—

1. That several terrible diseases, such as syphilis, cancer, consumption, and scrofulous diseases generally are widely scattered and communicated by vaccination. One vaccinator of twelve years' experience is made to say, "If I had the desire to describe one third of the victims ruined by vaccination, the blood would stand still in your veins." Another, "I have seen hundreds of children killed by it." A medical journal is quoted as saying that consumption has widely spread since the introduction of vaccination; which is very likely also true as regards lawn-mowers and pedestrian matches. A physician to the London Cancer Hospital declares that many of the cases of *cancer* treated at that institution originated with vaccination! A physician testifies before a Parliamentary committee that eleven out of thirteen children whom he vaccinated became syphilitic. Another declares that a large proportion of apparently inherited syphilis is really imparted through vaccination. A large number of cases of various kinds are cited with full and harrowing details, some of which have been subjects of discussion in medical circles during the past twelve or fourteen years.

2. It is charged that vaccination does not protect its subjects from small-pox. It is pronounced "not only an illusion but a curse to humanity"; "The greatest mistake and delusion in the science of medicine"; "A fanciful illusion in the mind of the discoverer, devoid of scientific foundation." It states that, out of 22,000 cases of small-pox treated in five London hospitals in five years, 17,000 had been vaccinated; and, furthermore, that, since compulsory vaccination had been established, the death-rate from small-pox had more than doubled. Such, in brief, according to these very remarkable statements, have been the results of vaccination in England, and it is in contrast with these statements that the results of vaccination as practiced in the city of New York are here presented.

Previous to the epidemic of small-pox in 1874–'75, vaccination had been fairly practiced, but in the same loose and unsystematic manner as was formerly the custom everywhere. Some physicians vaccinated the children of the families in which they were medical attendants and some did not. Vaccination was performed free to those who desired it at all the dispensaries, but no special care was taken to see that all the children in the several districts were vaccinated. Some physicians exercised skill and judgment in collecting the virus and doing the work of vaccination, while others were careless and slovenly.

There was no uniformity, no general supervision, and no responsibility.

In the autumn of 1874, notwithstanding some special attention was given to the matter, the number of cases of small-pox increased so rapidly, and the number of unvaccinated persons was found to be so great, that it was evident some more effective means must be adopted to meet the danger of a great epidemic. It was at this time that a permanent corps of vaccinators was organized under the charge of Dr. James B. Taylor, "Inspector of Vaccination," and under the general management of the Board of Health. The object of this corps was to visit systematically throughout the city, especially among the tenement-house population, offering free vaccination to all, and urging its advantages and even its necessity, in view of the epidemic character of the disease then prevailing.

During the following fifteen months ending in December, 1875, fifty-eight different physicians were connected with the corps, and an average of seventeen were constantly employed during that whole time. During this period, over 126,000 vaccinations were performed, all of which, so far as possible, were carefully watched and studied by competent medical men, not only for immediate practical results but also for the purpose of scientific deductions.

The method of procedure was as follows: It was important to commence the work with pure virus. Among those who had been interested in the careful study of vaccination here in New York was the late Dr. Jonas P. Loines, for many years house physician to the Eastern Dispensary. Twenty years earlier he had secured from abroad what was considered the best and purest virus to be obtained in any country. The use of this virus he personally superintended, and its results were carefully watched. It was kept separate from all other, and had proved protective and thoroughly satisfactory. This was the virus first used by the newly organized Vaccinating Corps.

At first no separate districts were assigned, but those localities most threatened with small-pox were sought out, and particular streets, blocks, or houses were designated for special attention. Later the city was districted and thoroughly canvassed. Each vaccinator made semi-weekly returns of his work to the inspector. These returns were on printed forms which required the name and address of the patient, whether front or rear house, number of room, age, nationality, parentage, and whether a primary or revaccination. At the inspector's office all these reports were carefully classified and recorded for future reference, primaries being kept separate from all others.

On the eighth day every case of primary vaccination was visited by a member of the corps specially qualified for the work, to observe the character and condition of the vesicle, whether perfect or in any way deficient, to revaccinate any cases of failure and to collect virus from perfectly healthy infants presenting perfect vesicles. All vac-

cinations not considered perfect, even though they had to a certain extent "taken," were either immediately revaccinated or the parents informed that the protection was not perfect, and advised to have the operation repeated at an early date. This work was also reported to the inspector, and the revaccinated cases again visited on the eighth day.

Between the twentieth and thirtieth days each case of primary vaccination was visited a second time to make sure that all was right, and deliver certificates of vaccination. If any unusual symptoms had occurred or the sore was tardy in healing, the case was taken in charge and treated until well. But even here the care did not cease. In each family where vaccination was performed a circular was left, printed in English and German, giving directions for the care of the vesicle, and directing parents to bring their children to the inspector's office at any time afterward, should any unpleasant effects appear which they might attribute to the vaccination—a privilege which they were not backward in claiming.

All the schools, institutions, asylums, workshops and factories were visited and vaccination offered. Two physicians were assigned specially to the public schools and the same care regarding reports, records, and revisiting was observed. Certificates were also given to those thoroughly protected in order to avoid the annoyance and labor of unnecessary examinations.

Thus the work of vaccination was for the first time carried on in a thorough and systematic manner, and thus it has been kept up ever since. Twice a year the tour of inspection and vaccination is made throughout the tenement-house region, factories, and all places where people are habitually brought together in large numbers in a more or less confined atmosphere. The schools are thoroughly canvassed about once in three years. Five years of such extensive, systematic and thoroughly studied work could scarcely fail of results of some kind either for good or for evil. During that time 270,970 vaccinations were performed by the Vaccinating Corps alone, independent of the great number performed at the dispensaries, and by physicians in their private practice. It remains to examine these results as regards the protection which vaccination affords against small-pox, and as regards the transmission of disease, which has constituted the great ground of prejudice against the practice of vaccination. Regarding the advantages or disadvantages of vaccination two main points present themselves:

1. Is vaccination a protection against small-pox?

2. Is it a vehicle for the communication of other diseases? Let the facts themselves speak; and the facts here presented, all of which occurred during the epidemic of 1874–'75, are drawn from the published reports of the Board of Health and from personal conversations with Dr. Taylor, the very efficient Inspector of Vaccination, whose excel-

lent judgment and ample experience entitle both his facts and opinions to great weight.

I. Concerning protection. 1. In a large tenement-house in East Third Street were nine German families. An unvaccinated child was taken sick with small-pox, and the case was kept secret until the child died. All the other people in the house were vaccinated except one family consisting of parents and three children. The parents did not believe in vaccination and persistently refused it for their children. All three children had small-pox and two died. No other cases occurred in the house.

2. The inmates of No. — East Eleventh Street were exposed to small-pox. The vaccinators found three babies whose parents refused to have them vaccinated. Within three weeks all three children died of the disease. There were no other cases in the house.

3. No. — St. Mark's Place. Three cases of small-pox had already occurred in the house. The inspectors found three unvaccinated children, but vaccination was refused. The two eldest children took the disease; the youngest was already dying of marasmus. No other cases occurred.

4. At No. — Tenth Avenue was a concealed case of small-pox already of twenty-one days' duration. He had been vaccinated in infancy, but not since. He died before he could be removed. His wife and four children had been successfully vaccinated just before the husband took sick, and, though they had all slept in the same room with this fatal case of small-pox twenty-one nights, not one of them took the disease.

Cases of this character, where the unvaccinated were selected and attacked by the disease, while the vaccinated, though equally exposed escaped, could be multiplied almost without limit. Here is one from the inspector's own experience:

Small-pox was in a tenement-house of eighteen families. Most of the inmates submitted to vaccination, but two children were found upon one floor and three upon another whose parents refused to allow it, though repeatedly urged. Within a short time all five of these children had the disease and three died. The parents of the three unvaccinated children had a fourth child who had been successfully vaccinated at school, and for which she received a severe beating at the hands of her father. This child, although sleeping in the same room with those who were sick and dying of the disease, entirely escaped.

No more striking examples of protection afforded by vaccination could exist than that furnished by placing infants on the first day of their vaccination in a small-pox hospital, filled with patients in every stage of the disease. This was frequently necessary during the epidemic, where the mother was attacked, and the infant must accompany her to the hospital; and, says the inspector, "not a single instance has occurred where the infant so exposed has contracted the

disease," even though the infant nursed the mother throughout the illness.

Experience has abundantly proved that, when babies *not* vaccinated are so exposed, the result has *invariably* been directly the opposite. In fact, the evidence in this matter is so abundant and of so conclusive a character that all who have taken the trouble to observe or study it during the past five years must be convinced that *perfectly vaccinated persons are absolutely protected from small-pox*, at least to the same extent as if they had already experienced the disease.

Why, then, it may be asked, do vaccinated persons have the disease at all? Simply because, in order to have the protection perfect, the vaccination must be perfect; and to this end two things are absolutely necessary: 1. The primary vaccine vesicle must be of proper size and character, and must run its proper and normal course. 2. Revaccination must be performed at proper intervals, namely, within five years after the primary, and again soon after puberty in those who are vaccinated in infancy, and at least one revaccination in those whose first vaccination was after maturity.

It is here that the great fallacy of statistics upon this subject is found; and this is why the English statistics before quoted show that, out of 22,000 cases of small-pox treated in the hospitals, 17,000 had been vaccinated. They had been vaccinated in infancy—perhaps properly, perhaps improperly—but in all probability had never been revaccinated. It should be once for all understood that, in order to have full protection, revaccination at the proper periods is just as necessary as the original vaccination.

It should be understood that a primary vaccination is not expected to protect for a long series of years, but only for a few years; and that after a limited time, although it may modify more or less the severity of the disease, it ceases to be absolutely protective, and must be renewed.

Statistics, however, show that, of persons attacked with small-pox, from three to four times as many deaths occur among those who have not been vaccinated at all as among those who are reckoned as vaccinated, though it may have been only in infancy. They also show that such vaccinations are nearly worthless as protection against small-pox after several years have elapsed, and very uncertain even in their power to modify the disease.

II. Concerning the transmission of other diseases by means of vaccination.

It may be presumed that if bad results of any kind were to follow vaccination, it would happen in primary cases, where the virus exerts its full influence of every kind. It has been seen with what care all these primary vaccinations have been watched during the past few years, the oversight extending even beyond the perfect healing of the arm. A circular was left in each family, requesting that any unfavor-

able symptoms which might subsequently arise, apparently as the result of vaccination, should immediately be reported to the inspector at his office. As a consequence of this invitation quite a number of complaints were received, every one of which was thoroughly investigated. It is fair, therefore, to suppose that every case of importance thus came under the observation of the inspector. Out of 24,395 primary vaccinations, 145 complaints were entered—scarcely more than one in 150 cases. On examination these were divided into four classes :

1. Ulceration and sloughing of the arm about the sore.
2. Inflammation and erysipelas.
3. Inflammation of the neighboring glands and sometimes abscess.
4. Various eruptions on the skin.

Two deaths occurred, both from erysipelas. Both these cases were in bad subjects, one being complicated with meningitis, the other being in a poor anæmic child with "such miserable surroundings as to preclude the possibility of recovery." In such subjects any operation, even the slightest, or any accident, an ordinary cut or bruise, without inoculation of any kind, is liable to be followed by most serious results. The vaccine virus can not be held responsible for the mischief in these nor any of the cases complained of, since in the same streets, even in the same houses, many other children were vaccinated with the same virus with perfect results. The fault was in the children themselves, their parentage, their constitutions, their habits and surroundings. So true is this that, if vaccinators could choose their cases, avoiding all bad or doubtful subjects for the sake of avoiding the prejudice aroused by a single unfavorable result, seldom indeed would a complaint be entered ; but, on the other hand, many a child fairly entitled to the benefits of vaccination might be left unprotected. These results are mentioned, however, that nothing may be covered up which was actually found as a sequel even if not a result of vaccination.

Looking for statistics or even single cases of disease actually transmitted from one person to another by means of vaccination, no such cases exist. Concerning syphilis the inspector says, "Among all the cases of bad results which we have seen, we have failed to find a single one showing any indications of syphilitic inoculation, nor have we ever met a case of this kind in all our experience." Only a very few such cases have been brought to notice as even suspected, and none which would bear investigation. They were either not syphilis at all, the most usual result of examination, or else showed some other and more probable way of receiving the infection.

But what of other terrible diseases—cancer, consumption, and all the other forms of scrofula—for which vaccination has been blamed ? No such cases have ever been brought to the notice of the inspector. The idea that such diseases can be so transmitted is absurd on its face, since it is certainly most difficult, if not utterly impossible, to repro-

duce any of them by any process analogous to that employed for vaccination.

All these reports and facts relate to vaccinations performed with humanized lymph, and previous to 1876. The most careful examination of every reported or suspected case among the 126,000 vaccinations performed up to that time failed to furnish a single case of the transmission of disease of any kind whatsoever from one person to another by means of vaccination.

In order, however, to avoid as far as possible the prejudice which was at one time so widespread in this matter, no humanized lymph has been used by the Vaccinating Corps for nearly three years. All the virus now used is eighth-day lymph taken from healthy calves carefully selected and kept in the country under the supervision of the inspector, exclusively for this purpose.

No very special advantage is claimed at present for this over properly selected humanized lymph; if, however, any difference is observable in the results, it is in favor of the bovine lymph, as affording fewer cases of troublesome inflammation.

One advantage is decided: it has tended to diminish a prejudice, and so remove in some degree an objection to vaccination.

It is in the face of an abundance of facts such as these, instead of the badly observed and badly studied facts of fifteen years ago, that intelligent people now must doubt the safety and utility of vaccination.

THE MOST POWERFUL TELESCOPE IN EXISTENCE.

By E. NEISON, F. R. A. S.

WHICH is the most powerful telescope in existence? Define the meaning which ought to be attached to the adjective "powerful" in this question. The most powerful telescope in existence is that existing telescope which can do the most work. The work of a telescope may be said to be to enable you to see and to enable you to measure. Therefore, that telescope with which you can see most and can measure best is that which can do the most work, and is unquestionably the most powerful telescope in existence.

Which is the most powerful telescope in existence?

Every one has heard of the two giant telescopes which were constructed nearly forty years ago by the late Lord Rosse, and which were erected at his residence at Parsonstown, about fifty miles from Dublin. The first great telescope constructed by Lord Rosse was a reflecting telescope with a speculum three feet in diameter and twenty-six feet in focal length. It was carried in a ponderous tube moving in a massive iron mounting by means of ingenious machinery. When

it was finished in the year 1840 it was considered the grandest instrument in existence, and from its employment in the study of the heavens enormous advantages were expected to be gained for astronomy. Scarcely, however, was this telescope out of the hands of its maker, than Lord Rosse resolved to construct a second telescope of still larger dimensions. With enormous skill, patience, and ingenuity Lord Rosse carried out this intention, and by the year 1846 had finished his second grand telescope, the instrument commonly known as "Lord Rosse's Telescope." It has a metal speculum six feet in diameter and fifty-four feet in focal length. This enormous mirror, which weighs nearly four tons, is placed in a great tube eight feet in diameter and fifty feet in length, and this tube is carried by a massive iron mounting supported by two lofty castellated buildings, each nearly sixty feet in height. The weight of the telescope and its mountings is enormous. By ingenious methods the observer who is using the telescope is placed in a kind of cage, suspended in the air from the mounting of the telescope, and carried up and down along with the instrument.

To this day this giant telescope of Lord Rosse's retains its position as the greatest telescope in existence. In its enormous size it has still no rival, in its massiveness and weight it is long likely to retain its preëminence.

Which is the most powerful telescope in existence?

Lord Rosse's giant telescope, of course, will be the answer of most people; it will be the answer of the great majority of scientific men; it would be almost the unanimous answer of the British Association, of that Section A which is supposed to keep the world informed of the great achievements of astronomy and of optics.

Is this the true answer? No.

To most people, to most scientific men, this answer will come like a shock, for to them it has long been a cherished tradition, an article of faith, almost an axiom, that Lord Rosse's giant telescope was the most powerful telescope in existence. To those astronomers who are observers, astronomers not star-gazers, it is well known that for years this giant telescope of Lord Rosse's has been beaten in power by far smaller and more compact rivals. In fact, it is doubtful whether in real power it is much superior to its smaller companion, the three-foot telescope.

There are many who judge a telescope by its size alone, who compute its excellence by aid of a two-foot rule, and a knowledge of its cost in pounds. With them a telescope with a metallic speculum weighing four tons and measuring six feet in diameter, with a tube fifty feet long, and costing a thousand pounds, ought to give so much light, have such and such separating power, and show this or that object. It is true with small telescopes a great deal may be done in this way, but experienced observers know that the real power of a telescope can only be ascertained by a study of what it has done. Tried by this

test, the giant telescope of Lord Rosse breaks down. It has not the accuracy of definition which constitutes the real power of a telescope, for it is mainly upon this that depends its capability for doing work. Compared with the metal specula which were made at the time when Lord Rosse's telescope was constructed, the great speculum of Lord Rosse's instrument might come out with credit. But great improvements have since then been introduced into the manufacture of reflecting telescopes, and the present silver-on-glass reflecting telescopes successfully rival the finest achromatic telescope in definition and in power.

In days gone by repeated reference was made to the wonderful things which could be seen upon the surface of the moon with these two giant telescopes of Lord Rosse's. Picturesque descriptions were given of the minute features which were visible; amazement was often expressed at the small objects which could be seen. Still more interesting accounts were given of what *ought* to be visible—a carpet of pronounced pattern as big as Lincoln's Inn Fields, the Castle at Dublin, the Court-house at Cork, a house, or even a man, provided he were big enough. All these *ought* to be seen if they happened to be on the lower surface. Yet when we come to consider what it really is which is described as being seen, when we calmly examine the various drawings which have been made by the aid of one or the other of these great telescopes, then we find that they show nothing which can not be distinctly seen and drawn by the smallest astronomical telescope of high excellence. An enormous blaze of light is gathered by the telescopes, but all this light reveals nothing which can not be seen with far greater ease in a far smaller telescope. There are in existence a number of drawings of the planets, and observations of their satellites; there are also observations of close double stars, or faint companions to bright stars, all made with one or the other of these two telescopes. Yet nothing has been seen which is beyond the power of a good astronomical telescope of comparatively moderate aperture. It is only in observing the dull, ill-defined nebulæ that Lord Rosse's great telescope has any exceptional advantage, though even in this respect it is probably much overrated. As an astronomical telescope either of Lord Rosse's telescopes would be fairly beaten by either of the fine eighteen-inch reflectors which are now in existence.

If, then, Lord Rosse's great telescope is not the most powerful in existence, what answer is to be given to the question with which we commenced? Which *is* the most powerful telescope in existence? There are the great refractors of Poltava and of Cambridge, United States, each of fifteen inches in diameter and twenty-three feet in focal length. There is the still larger refractor of Chicago, with an aperture of eighteen inches and a focal length of twenty-three feet. All these instruments are of high excellence in defining power, the essential point where Lord Rosse's breaks down. There is the reflector of Mr. Las-

sells, with its metal speculum of two feet in diameter and its tube twenty feet in length. There is the great Melbourne reflector, with its great metal speculum of forty-eight inches in diameter, the second largest telescope in the world, but by no means so sharp in definition as might be desired, so that it failed to reveal the satellites of Mars which were seen with an instrument of not one sixth the diameter in Europe.

There is also the great reflector of the Paris Observatory, with a silver-on-glass speculum nearly four feet in diameter, an instrument whose power is seriously injured by the imperfect definition arising from the flexure of its thin speculum. There is also the large refractor constructed for Mr. Newall, of Gateshead, with an object-glass twenty-five inches in diameter mounted in a tube nearly thirty feet in length.

But all these instruments must yield the palm to the great refractor of the United States Naval Observatory at Washington, a splendid instrument, with an object-glass twenty-six inches in clear aperture and thirty-three feet in focal length. This magnificent instrument is equatorially mounted and driven by clockwork, so that it is complete as an astronomical telescope. The Washington refractor is, however, not merely a telescope of great dimensions; like more than one of those previously mentioned, it is an instrument of high optical excellence. Its definition is crisp and sharp, and it brings every ray of the enormous amount of light which it collects to a sharp focus as a very minute point, so that none is wasted. It was with this fine telescope that Professor Asaph Hall made his famous discovery of the satellites of Mars, that Mr. Burnham discovered a number of the most minute companions to the brighter stars, and that Professors Newcomb, Holden, and Hall have observed and measured the smallest satellites of Saturn, Uranus, and Neptune. It is this magnificent instrument which is supposed by most astronomers to be the most powerful telescope in existence. Then our answer to the question with which we have commenced ought to be—the great refractor of the Washington Observatory. No!

Then which is the most powerful telescope in existence?

The most powerful telescope in existence is the magnificent new reflecting telescope which has been just finished by Mr. A. Ainslie Common, and is erected at his residence at Ealing. This telescope has a silver-on-glass speculum, thirty-seven and a half inches in diameter, and a focal length of just over twenty feet. It is equatorially mounted in a novel but most efficacious manner, and is driven by a powerful clock controlled in an ingenious manner by a method invented by Mr. Common. This new telescope, which has only been finished about a month, has turned out a great success, and is unquestionably the finest and most powerful telescope in existence.

For the last three years Mr. Common has had in his observatory a

fine silver-on-glass reflector, with an aperture of eighteen inches and a focal length of nearly ten feet. This telescope was mounted by him on an equatorial stand of his own design, on what is known as the "Sissons" principle. For efficiency, power, and excellence this eighteen-inch reflector is as yet without a rival in England, and was only beaten, perhaps, by the great refractor of the Washington Observatory. With this instrument were made a number of observations of the faint satellites of Saturn and Uranus, which rendered the Ealing Observatory a familiar name to all astronomers. When, in 1877, the astronomical world was electrified by the announcement of Professor Asaph Hall's discovery of the two satellites of Mars, it was to Ealing that astronomers looked for systematic observations of these faint objects, and it was from Ealing Observatory that came the only systematic series of measures of these objects which has been furnished by England. Astronomers may congratulate themselves, therefore, upon this new telescope being in good hands, and in an observatory where it will not be allowed to rust in idleness like so many of the finest instruments in England.

Satisfied from the performance of his eighteen-inch Newtonian reflector that it would be possible to successfully construct much larger instruments of this kind, it seems to have been about two years ago that Mr. Common first seriously thought of constructing a very large reflecting telescope with a silver-on-glass speculum. It was obvious that this would be a serious undertaking, and one which would require much thought and ingenuity to carry it out successfully. Many difficulties would require to be boldly faced and successfully overcome. The expense alone would have been sufficient to deter most men. Experience, skill, courage, perseverance, money—all would be required if success was to be won.

It was decided to first undertake the manufacture of a telescope with an aperture of thirty-seven and a half inches and a focal length of about eighteen or twenty feet. This was a much shorter focus than had usually been thought essential for an instrument of this large aperture. Generally instruments of this kind are made with a focal length of from nine to ten times their diameter. This would correspond to about thirty feet focus for a speculum of the given size. The fine performance of his eighteen-inch telescope had convinced Mr. Common that it was not necessary to give a greater focal length than fifteen or sixteen feet. But there were two conflicting interests to be reconciled. The shorter the instrument the easier it would be to mount, and the easier to observe with; but, on the other hand, the longer the focus the better it would be for taking photographs of the heavenly bodies, and this last was one of the main uses that the new telescope was intended for. With the view of best reconciling these two views the instrument was designed with a focus of some twenty feet.

The very first step to be taken was to undertake the manufacture

of the glass speculum, and here at the outset an enormous difficulty presented itself. To make a speculum of the required dimensions it was necessary to have a disk of good crown glass about thirty-eight inches in diameter and from six to nine inches in thickness. Well, purchase such a disk; or rather, as it was not likely that such a thing could be bought ready-made, why order one. This seems feasible enough. But there was not a firm in England who would undertake to make such a thing. In fact, at the time, the opinion was freely expressed that such a thing could not be made. This was a serious obstacle, for nearly all the glass used for optical purposes came from England. Determined not to be baffled, Mr. Common applied to a French firm, and they produced the disk of glass which was essential before a single step could be taken. The first difficulty was faced and overcome.

After mature consideration the grinding and polishing of the speculum into which this glass disk was to be turned was intrusted to Mr. G. Calver, of Widford, a well-known maker of glass specula. From its enormous size, over twice as large and ten times as heavy as any speculum which had ever been manufactured before, it was necessary to construct new and more powerful machinery and even a new building. Nothing daunted, however, Mr. Calver agreed to do his best to turn this great mass of glass into an excellent speculum, though of course he could not guarantee anything, the entire risk necessarily remaining with Mr. Common.

This settled, the greater portion of the task remained to be faced. Given a speculum of the specified size, how was it to be mounted, and how was it to be used? 1. The glass speculum must be mounted with such care that, despite its enormous weight, it must nowhere bend by as much as one ten-thousandth of an inch. 2. The glass speculum and the iron cell which supports it must be fastened at the end of a tube some twenty feet in length, and this tube must be supported by an elaborate mounting by which it can be pointed to any desired part of the heavens, and moved by clockwork so as to follow the apparent motion of the celestial bodies. 3. Arrangements must be made so that an observer can always use the telescope, and be enabled to look through the eye-piece of the telescope whatever position it may be in —no slight task, seeing that the said eye-piece must in some positions of the instrument be over twenty feet from the ground. Lastly, the telescope must have an observatory which will shield it from the weather, and yet permit any part of the heavens to be examined with the telescope.

When the instrument has a metallic speculum, like the large reflecting telescopes of Lord Rosse and Mr. Lassells, and that at Melbourne, it is much easier to satisfy the first condition than when the speculum is made of glass; for it is possible to cast the speculum with grooves, projections, and recesses in its back, by means of which the task of supporting it is much simplified. With a glass speculum it is

not practicable to have these aids, so that the back of the speculum is cast quite flat, and usually rests on a flat plate of metal. By an ingenious method of balanced arms Mr. Common has contrived to support the speculum so that it is perfectly free from flexure. Thus the first point was secured.

The second point, or the method by which the telescope should be mounted, was a problem which required long and serious consideration. Mr. Common devised a new and most ingenious method, which, after long consideration, he thought would furnish a means of steadily supporting the telescope. In this steadiness is most essential, the slightest vibration, vibrations absolutely invisible to the eye, would ruin the performance of a telescope. The weight of the moving part of the telescope amounts probably to four or five tons, and this has to be kept in motion by a clock, yet it must not be liable to the least tremor or vibration. The difficulty of the problem is evident. His plan of a mounting was submitted by Mr. Common, for criticism, to several well-known astronomers, who might be supposed competent to advise on this subject. As might have been expected, very diverse opinions were expressed ; at most, one seemed to decidedly favor the plan, others seemed doubtful, and more than one were decidedly adverse. The result was, to leave that matter much as it stood at first, so that Mr. Common decided to persevere in his original design. The success which has crowned his labors shows that he was correct in his judgment. It would be impossible to describe the method of mounting employed without the aid of several detailed drawings, but reference may be made to one ingenious point. As in all equatorial mountings, nearly the entire weight of the moving part of the telescope (in the present telescope five tons) rests on the bottom pivot of the polar axis. This pivot, therefore, is exposed to enormous friction, and is a common cause of vibration. To obviate this, Mr. Common, by an ingenious arrangement, supports the whole polar axis in mercury, thus taking off nearly the entire friction, and the whole instrument moves as if it were floating. By this means he is enabled to drive the whole telescope with an ordinary train of clockwork, regulated by the governor, which he had invented for his smaller telescope.

The last two points specified above are obtained by making the observatory itself the ladder by which you approach the eye-end of the telescope, and the whole observatory revolves on iron wheels running on a circular railway. By means of a wheel on your left, you can raise or lower yourself at pleasure, and observe with the telescope in any position. The whole observatory only requires moving about once in two hours, and can be moved with ease by one hand.

Within a year of its being begun, the telescope was rapidly approaching its completion. The great speculum had been brought to the right shape, and was partially polished, and every day the an-

nouncement was expected that it was completed, or at least only required the final finishing touches. Suddenly a telegram arrived—an ominous thing. Was it to announce an imperfect figure? This would be a most annoying thing, for it would require the whole to be reground and repolished. But no, it was very brief, but it announced a terrible misfortune. It was a pressing request to come down at once. *The whole speculum had burst into a thousand pieces.*

It was a terrible blow, for it was the very misfortune which had been prognosticated by the English manufacturers and by the greater number of astronomers, including those who had had much experience in the construction and use of specula. The explosion had been terrific. The whole workshop was covered with jagged, torn masses of glass, varying in weight from ten or twelve pounds to an impalpable dust. Mr. Calver had had a narrow escape, but he and his workmen escaped without serious injury. The monetary loss was great, and bade fair to be greater, for with the loss of the speculum the rest of the telescope became useless. It might well seem that they were right who held the view that large silver-on-glass specula were impracticable, as from the difficulty in annealing large masses of glass they might be expected to break at any moment.

Within an hour or two of receiving the telegram announcing this terrible mishap Mr. Common was in the library of the Royal Astronomical Society. While there he was met by a friend, a fellow astronomer, who, being aware that news was daily expected of the completion of the great speculum, asked him for the latest intelligence. Mr. Common calmly handed him the fateful telegram. He was thunderstruck, for it was so unexpected, and he was one of those who had looked for much gain to astronomy to accrue from the construction and subsequent employment of this grand new instrument. After expressing, no doubt imperfectly enough, his sorrow, sympathy, and disappointment, he naturally put the question, "What can you do now?" The answer came gently enough: "Do? Why, I have telegraphed over to Paris to see if I can't get two more disks of glass. It will be one to spare in case of another explosion."

Success must crown indomitable courage like this. The new disks arrived, and were duly transferred to Mr. Calver. One was selected, and, after much labor, ground, polished, and finished. The remaining portion of the instrument and the observatory were pushed on as quickly as possible. On August 1, 1879, the instrument was complete, and the grandest and most powerful telescope in existence stood finished before its maker, designer, and owner.

An instrument of this large aperture will take a long time to thoroughly test, but it has stood triumphantly all the tests which have been applied hitherto. It has been tested on the moon, a most crucial test in experienced hands, on Jupiter and Saturn, and on faint companions to bright stars. In all cases satisfactory results have been

obtained.* This proves that the telescope must be at least of fine quality, and it bids fair to turn out of the highest excellence. It has been used to take photographs of the moon, with results very satisfactory to those who are experienced in these matters. There can be no doubt, therefore, of its claims to be a success, so that ere long it will take its place, in the eyes of most astronomers, as the greatest optical instrument in existence, and the credit of having manufactured and of possessing the most powerful telescope in existence has now passed from America back to England.

It may be legitimately asked, What will be the future work of this grand instrument? Will it be used to increase our knowledge of astronomy, or will it be allowed to rest in idleness like so many other fine instruments? It is to be trusted, and it may be safely anticipated, that the former will be its fate. It will wear out, not rust out. There is much in astronomy which this grand telescope can do. It can be used for observing the faint and difficultly visible satellites of Mars, Saturn, Uranus, and Neptune. All these pressingly want observing and measuring, and there are few telescopes of sufficient power and excellence to do the work wanted. It can be easily done with the new one. Then there is the important question to be settled, Are there other satellites to those planets than those known? To this telescope will fall the task of searching for a third and more distant satellite of Mars, for a fifth satellite to Jupiter, for a ninth and tenth satellite to Saturn, for a fifth and sixth satellite to Uranus, and perchance half a dozen new moons of Neptune. Moreover, there are the extremely interesting problems connected with the minor planets. Does Vesta, Juno, or Pallas, possess a satellite or satellites? If so, their discovery would be a great thing for astronomy. Astronomers suspect that away beyond Neptune there may be still another giant planet, still another member of the solar system. If so, it will be very faint, and it will require a powerful telescope to search for and discover it.

There is yet another field in which this new telescope may reap great advantages for astronomy. It is suspected that more than one of the stars, those distant suns, may be attended by opaque, dull planets. Mathematical analysis has already pointed to the existence of these attendants. It remains for the telescope to discover them. If the new Ealing reflector be really of the very highest excellence, it will be with that instrument we ought to look for these attending planets, these members of a foreign solar system.

Lastly, there is the great field of photography. The new telescope takes instantaneous photographs of the moon two and a half inches in diameter, photographs which can be enlarged with ease to good pictures of the moon a foot in diameter—pictures which will be valuable for astronomy, not mere interesting curiosities of science. It will,

* Lately this telescope has shown the outer satellite of Mars three weeks before it was thought possible it could be seen with the great telescope at Washington.

moreover, take photographs of Venus, Jupiter, Mars, and Saturn, showing much detail, and capable of being enlarged to half an inch in diameter. These planetary photographs will be of great use, as recording in unmistakable characters the true position and aspect of these planets and their satellites at different known epochs.

The foregoing sketch will show that in constructing this new instrument Mr. Common has contributed in a most important degree to the advancement of astronomy.—*Popular Science Review.*

THE MORAL SENSE IN THE LOWER ANIMALS.*

By W. LAUDER LINDSAY, F. R. S. E.

ALL the ordinary definitions of what is variously called in man the *moral sense*—sentiment, feeling, faculty, or instinct—apply, though not necessarily equally, in the same degree, with quite the same sense or force, to an equivalent mental attribute or series of psychical qualities in other animals, and which attribute or qualities in other animals there is no good reason for distinguishing by any other name, simply because they are to be found in animals zoölogically lower than man.

Thus the moral sense in man has been defined by different classes of authors to be, or to include—

1. A knowledge, appreciation, or sense of—
   a. Right and wrong.
   b. Good and evil..
   c. Justice and injustice.
2. *Conscience*, involving feelings of approbation or the reverse in relation to ideas of right and wrong.
3. The approval of what is conducive to well-being, and the disapproval of the reverse.
4. Sense of *duty* and of moral obligation.
5. Appreciation of the results of *honesty* and dishonesty.
6. Virtue or virtuousness, including especially such moral virtues as conscientiousness, scrupulousness, integrity, compassion, benevolence, fidelity, charity, mercy, magnanimity, disinterestedness, chastity, modesty.

There is not one of these moral qualities that is not possessed, sometimes in a high degree, by certain of the lower animals, and more especially the dog; and there are many authors, who have been desirous of drawing marked psychical distinctions between man and other animals, who have nevertheless felt themselves compelled by the evi-

* From advance sheets of "Mind in the Lower Animals." By W. Lauder Lindsay, M. D., F. R. S. E., etc. 2 vols. In press of D. Appleton & Co.

dence of facts to concede to these other animals, or certain of them, the possession of morality akin to that of man. Agassiz, for instance, grants them morals; Froude speaks of their principles of morality; Brodie refers to the moral sentiments as occurring in gregarious animals; Shaftesbury allows to them a sense and practice of moral rectitude; Watson gives instances of their moral feeling, and Wood of their conscience. And certain animals have even been described as possessing a moral law and codes of morals.

The dog, at least, frequently exhibits a knowledge of *right and wrong*, making a deliberate *choice* of the one or the other, perfectly aware of and prepared for the *consequences* of such a selection. The animal has occasionally the *moral courage* to choose the right and to suffer for it, to bear wrong rather than do it (Elam). Not only does this frequently noble animal know the right, but it dares to do it, enduring the expected, the inevitable, consequent suffering. One of the many evidences that the dog is sensible of right doing is to be found in the familiar fact that when it performs an action which to it seems meritorious, or which it has reason to believe its master will deem so —when it saves a life, or successfully defends a trust, or resists some great temptation—it looks at once for some sign of the said master's *approbation*, perhaps for some reward. There are both the self-approbation or self-satisfaction of the *mens conscia recti* and an expectation of man's approval. The animal is gratified if such approval is in any form vouchsafed, disappointed if it be withheld.

It must also distinguish between the right and the *expedient*—what would be most for its own interest to do. In other words, it is just as apt as man is, and not more so, to take a *selfish* view of all affairs—to consider how they are likely to affect its own personal interests. The choice that is finally made between the right, the expedient, and the wrong is determined by a variety of considerations—by conflicting emotions, by the balancing of probabilities and inclinations, by the degree or kind of temptation, by the presence or absence of witnesses, especially human, by other specialties of an animal's position, by the nature and extent of its moral training, by the character of the rewards and punishments offered on previous occasions. In the dog there is sometimes obviously the same kind of conflict and collision between virtue and selfishness, between a sense of what is *right*—which is too generally also what is painful, what calls for terrible self-denial and suffering, including the physical pangs of hunger and thirst, as well as the moral pangs, say, of unsatisfied revenge—and a sense of what is simply pleasant and profitable.

Temptation frequently begets in the dog, cat, and other animals the same kind of mental or moral agitation, and the same sort of result, as in man. Sometimes we can see—in the dog, for instance—the whole play of the animal's mind—the battle between its virtuous and vicious propensities, its promptings to the right and its endeavors

to stick by the right, its longing for the wrong—for the titbit, which it knows it would be improper to steal—and the final triumph either of virtue or temptation. The poor animal, knowing or feeling the weakness of the flesh, sometimes has the moral strength, the force of character, the good sense, to *avoid temptation* altogether. But dogs, like men, are apt to have the most trying temptations thrust unexpectedly upon them, and then comes the tug of war of the appetites and passions—the moral turmoil that may make shipwreck of or that may strengthen virtue. Sometimes, then, by the dog, as by the man, temptation is successfully resisted after perhaps a series of protracted and painful moral struggles that have been very apparent to the onlooker. Unfortunately, however, equally in dog and man, the *resistance* of temptation is less common by far than non-resistance or non-success in resistance, the result of which is various forms or degrees of wrong-doing.

But in the dog, cat, and other animals this *wrong-doing* is accompanied by a perfect consciousness or conception of the nature of their behavior. They are quite aware of being engaged in actions that will bring inevitable punishment, which penalty, moreover, they are sensible they deserve. Miss Buist gives the history of a pet canary that was given to prancing about on her piano-keys, and that knew it was wrong in so doing.

Abundant evidence of a consciousness of *wrong-doing* is to be found either generally in the—

1. Pricks, stings, or pangs of *conscience.*
2. The various expressions of a *sense of guilt*—for instance, the—
   - *a.* Sneaking gait.
   - *b.* Depressed head, ears, and tail.
   - *c.* Temporary disappearance.
   - *d.* Permanent absconding; desertion of home and master.
3. The multiform exhibitions of *contrition*, regret, repentance, self-reproach, remorse—

Or more specifically in the—

4. Efforts at *reconciliation* and pardon, including the giving of peace-offerings.
5. Various forms of making *atonement.*
6. *Concealment of crime* or its proofs.
7. Artifices for *escaping detection* or conviction.
8. *Non-resentment of punishment.*
9. Sensitiveness to *reproof*, or even under mere reference to former delinquency.
10. *Punishment of offenders* by and among each other.

Conscience is frequently as severe a monitor in other animals as in man, its reproaches as stinging and hard to be borne, its torments sometimes intolerable. We may speak quite correctly, for instance, of the *conscience-stricken* animal thief, the cat or dog caught in the

act of pilfering from the larder. The signs of detected and acknowledged guilt are the same in kind as would be exhibited under parallel circumstances by the human child. The animal, like the child, if rendered sensitive by previous moral training, shows unmistakably its consciousness of delinquency. Its look and demeanor alike eloquently bespeak its sense of detection and disgrace. It understands its master's accusation as conveyed by eye, tone, word, gesture, and it either makes instant effort to escape the punishment which it knows it has incurred and deserved, or, if escape be hopeless, it, as calmly as may be, awaits the said punishment, and does not resent it, as it would did it feel it to be unmerited. A bitch having once eaten a quantity of shrimps intended for her master's dinner sauce, had only to be asked ever after, "Who stole the shrimps?" to cause her to take to ignominious flight—ears and tail down—going to bed, "refusing to be comforted . . . . the picture of shame and remorse," while we are told "she never stole again" ("Animal World").

A young dog having committed some offense against the established rules of his master's household, "after we had shaken our heads at him and turned away . . . . although he must have been very hungry, would not touch his food, but sat close to the door, whining and crying, till we made it up with him by telling him that he was *forgiven* and taking his offered paw, when he ate his supper and went quietly to bed." Another dog, "if he has done anything wrong, comes up looking very much ashamed of himself and voluntarily offers his paw" (Wood). Here we have decided efforts at *propitiation* of an offended master or mistress, and after the fashion of man's reconciliations by the shaking of hands, as nearly as the dog can imitate this arrangement. There are cases in which regret or remorse leads to the restoration of stolen goods. A dog that had murdered a duck was caught in the act of burying its dead body—that is, of concealing the evidences of his crime. "So deeply was his conscience pricked that when he found himself arrested by a bush he ran the risk of dying of cold and hunger rather than allow himself to be discovered" (Wood). When a large, magnanimous, powerful dog—for instance, of the Newfoundland breed—has allowed impulse or passion to hurry it into some rash act, such as killing or too severely punishing some puny pug that has been merely forward, impudent, or annoying, it frequently and eloquently expresses its shame, regret, or remorse.

As in man, conscience or conscientiousness sometimes has its strange or striking vagaries, eccentricities, or inconsistencies in other animals. Thus a retriever that would himself touch no food belonging to his master, yet offered no objection to theft of the same food by a cat, nor did he decline to accept a share of *her* plunder (Wood).

Not only do animals feel their own wrong-doing, but they appreciate evil or evil deeds in their young and in their fellows, including other genera and species, and man himself. They show this, for in-

stance (1), by the punishment of offenders, if not of offenses, as well as (2) by the prevention of threatened wrong-doing or the defense of the wronged, or (3) by the resentment or revenge of injury or injustice of any kind. Thus various animals resent and revenge the wrongs committed by *man* not only on themselves or their fellows, but even on brother man; and this sense of wrong or injury inflicted upon others leads sometimes to their *defense of man* against his fellow man. A case happened recently in Ireland of a pet cow that defended its mistress against the ill usage of its master, its mistress's husband; and many instances have been recorded of the dog, elephant, and horse doing similar kindnesses to their human favorites. It ought to be not a little humiliating to man's pride that the so-called "lower" animals have so frequently to act as *mediators* in human quarrels—to defend lordly man against his own species.

In the same sense in which it can be said that the dog and other animals are endowed sometimes with a perception of wrong, it may also be said that they acquire a sense of the *illegality* of certain not only of their own actions, but also of man's. Human tribunals have apparently regarded sheep-stealing dogs as conscious of the illegality of their deeds, as sensible of the nature of their nefarious employment, as aware of the character of their offense or crime, as alive to the chances of detection and of the necessity for secrecy or concealment, for nocturnal operations, for the avoidance of being found associated with any of the evidences of guilt, as feeling that they deserve punishment and that they will receive it on capture or conviction. These tribunals have, in other words, recognized the power the guilty animals have possessed of selecting between the right and the wrong, and of their having chosen the latter with full knowledge of consequences. And in all these respects human judges have so far formed correct conclusions or decisions, though they have erred in forgetting that the criminality in such cases has been the evil fruit of man's education of his animal accomplices. The dogs of the brigand, smuggler, or poacher, like those of the sheep-stealer, display a knowledge of the illegality of the operations in which they are habitually engaged. They take all means of avoiding custom-house officers or gamekeepers, deliberately making use of all kinds of deception; but to all this they are trained by man.

No doubt what is popularly spoken of as a sense of right or wrong, of legality or illegality, in the lower animals may, or will if strictly analyzed, be reduced to a distinction between what is *forbidden* and what is *permitted* by man, who is recognized as a sufficient lawgiver and administrator—what will bring *punishment* on the one hand and *reward* on the other. But this is just the kind of feeling as to right and wrong, legality and illegality, that exists in the savage adult, that is generated at first in the civilized child, that is exhibited (if at all) in the criminal, the lunatic, or the idiot. It can not be truthfully

affirmed that *abstract* or refined *ideas* of moral good and evil are common to all ranks of men, or are innate even in civilized man. In our brother man, and with all the help that spoken and written language can give us, there can be no doubt of the difficulty, frequently the utter impossibility, of knowing whether any and what conceptions exist as to right or wrong, good or evil, justice or injustice, honesty or dishonesty. It need, therefore, be no matter of surprise if we can not ascertain or demonstrate the presence or absence of any sort of definite conceptions on such subjects in the dogs, fowls, or other domestic animals that are so constantly under man's observation. Practically, however, as has been seen, as practically as in whole races of man, the dog and other animals give unquestionable evidence that they know what, according to man's law to them, is right and wrong, and they prefer to do the one or the other according to their individuality and the character of their previous moral training.

Monkeys and other animals sometimes show, as much as does the human child, a very decided enjoyment of *forbidden* pleasures, not only knowing that they are, but because of their being, interdicted.

The dog, horse, mule, elephant, and other animals have frequently a distinct sense, feeling, or knowledge of *duty*, trust, or task; and this not only as regards their own personal obligations, but in so far as duty of various kinds is attachable to other individuals of the same species, or to those of other genera and species, including man himself—when, for instance, such duty of man's has any immediate reference to, or connection with, themselves. In other words, they have clear conceptions of their own duties and of the duties of others, including man, in relation to them.

The discharge of their own duties, which in many instances are *self-imposed*, involves, or is characterized by—

1. An *understanding of the nature of the work* to be executed—of the duty required, for instance, by man.

2. *Conscientiousness* in the discharge of duty, which again implies—

   a. Sterling *honesty* and fidelity.
   b. Willingness or *zeal.*
   c. Regularity, including perseverance, patience, and method.
   d. Accuracy, based on high intelligence.

The working elephant requires that the nature of its work should be explained to it, to as great an extent as possible demonstratively—by illustration. It very quickly and readily comprehends what it is that man wishes and expects it to do, and it very soon learns to execute its task without supervision, bringing to the discharge of its duty so much zeal or heartiness, so much conscientiousness, that it frequently displays an obvious *dread of failure* in, or of inability for, the due fulfillment of its trust, even when the causes of such failure or incompetency, where they exist, scarcely come within, or are altogether beyond,

the animal's control. There are such things in the dog, elephant, horse, and other animals as excess of zeal, wrong ideas of duty, mistakes in the mode of discharging it, and *morbid conscientiousness.* Man's cruel taunts not unfrequently lead the too willing horse or elephant to the attempting of tasks for which their strength, or lack the reof, does not qualify them, and death in or from such attempts is the occasional result; while the dog sometimes carries its honesty or fidelity in the defense of a trust to a ridiculous extent, or displays qualities, noble in themselves, under absurd circumstances. The dog's anxiety to learn his duty has been pointed out by the Ettrick Shepherd, who thus writes of his celebrated Sirrah: "As soon as he discovered that it was his duty [to turn sheep], and that it obliged me, I can never forget with what anxiety and eagerness he learned his different evolutions."

Duties that are *voluntarily assumed*, that are frequently of an irksome and even of an unnatural kind, are sometimes discharged in the most admirable way—for instance, by self-constituted *foster-parents* that have adopted orphaned or deserted young, often belonging to other genera and species, and even to natural enemies.

Quite as frequently, perhaps, parental or maternal duties of a natural and important character are *delegated or left* to any other animal possessed of a sufficiently powerful charity or compassion, a sufficiently strong maternal or parental "instinct." The duties of parentage or otherwise may be simply left undischarged without the slightest regard to the results of such neglect; every opportunity may be taken of shirking work that is disagreeable, or a task of whatever nature is executed in a very perfunctory, perhaps merely nominal way. There is, in other words, in some cases just as decided an insensibility to the claims of duty, just as marked a cold indifference to its discharge, as in other cases there are conscientiousness and kindliness. It is only fair, however, to bear in mind that such *apathy*, frequently of an obviously unnatural character, is one of the common results of *mental defect or disorder*, just as it is too frequently in man himself.

The dog frequently makes duty and its discharge paramount to all other considerations. To it are sacrificed even revenge on the one hand, or temptations to the pursuit of game, or to access to food, on the other. Death itself is sometimes preferred to the desertion of a trust or charge (Watson). Many a dog restrains all its natural propensities under a sense of duty and responsibility. When on "duty," intrusted with a message from a master, it very literally places "business before pleasure"; its self-control may even prevent desirable or necessary self-defense.

Whether it be from a sense of justice, of duty, or of conscientiousness, it is a fact that certain working dogs and other animals not only attend faithfully to their own duties, but see that their companions give equal attention to theirs. They *exact duty* or work from, or enforce it in, their colleagues (Watson).

Certain of the lower animals have a very decided sense of *justice and injustice*, of equity or fairness and the reverse. Thus the dog, horse, mule, ass, camel, elephant, and other working animals have a feeling that "the laborer is worthy of his hire"; that they deserve a certain meed of praise, credit, or reward—a certain return in food and drink, in domestic comfort or personal attention—for service rendered. There is a clear recognition of the value of service—a knowledge of personal deserts. Hence they so frequently exhibit a sore sense of ill-requital of hard labor or of self-sacrifice. Punishment which they know to be undeserved they resent—sometimes dangerously to man—and in doing so they discriminate and estimate man's injustice.

The bread-buying dog does very much the same thing—detects and protests against man's unfair dealing when, offering its penny for a roll, a baker tries, waggishly or otherwise, to cheat it by giving it something of inferior value or refusing it a *quid pro quo* at all.

There must further exist in certain animals some perception of the distinction between spoken as well as acted *truth and falsehood*, fact and fiction; for we are told, for instance, that the parrot sometimes not only detects but denounces with the utmost indignation man's verbal falsehoods ("Animal World"). On the other hand, one of the occasionally base or bad purposes to which the same bird applies its wonderful gift of speech is *mendacity:* so that it is capable at once of "telling lies" itself and of detecting and reprimanding falsehood in man.

A certain sentiment of *decency*, modesty, or propriety occurs in various social animals, illustrated as it is by—

1. Their sexual bashfulness and chastity.
2. Their care of the dead, including the—
3. Use of dying-places and cemeteries.
4. Their employment of latrines or their equivalents.

It has to be remarked that the moral virtues are illustrated mainly by or in those animals that have directly or indirectly received their *moral training* from man—such animals as the dog, elephant, and horse. As a general rule—to which there are exceptions both in man and other animals—the human child and the young animal can equally be educated both to *distinguish and do the right.* In the formation of their characters *moral virtue* may be made to dominate over moral vice though it is probably impossible in either case to extinguish the latter. Moral perfectibility may be aimed at, though it can not be attained; but the degree of moral excellence attainable is such in other animals, as in the child, that it should stimulate man to put forth all efforts in the moral training of both.

MIDDLE-AGE SPIRITUALISM.

THE doctrine of human intercourse with invisible beings or spirits is as old as superstition, and has its fashions, or, rather, it takes on different phases according to the degrees of ignorance and stupidity that characterize society. It was one thing in Greece and Rome, and a very different thing in the middle ages. In the former there was a mythologic machinery of gods and goddesses, who meddled actively with terrestrial affairs, both in peace and war. This was the dignified sort of spiritualism that is embalmed in classical literature, and which continues to form the corner-stone of a "college education."

The spiritualism of the middle ages took a very different shape. It was more intense, realistic, practical, and vulgar—more earnest, and, we are bound to say, more honest. The spirits were brought to bear, so to speak, more intimately upon common life. The line between good and bad spirits was more sharply drawn; they were angels or demons, ever working mischief or benefit to mankind. The art of evoking spirits became a kind of craft under the names of divination, magic, sorcery, enchantment, necromancy, and witchcraft. In the modern survival of these old practices of evoking spirits we get very different results. The ghosts believed to be called up by manipulation are of a more harmless character; and the object seems to be rather to get the spirits out, than to get anything out of them. They are summoned more as a matter of curiosity, and for the solemn amusement of credulous and vacant minds.

Science has worked a great change in relation to this subject. It has drawn the teeth of mediæval ghostology. Though it has not extirpated the belief in spirits, it has greatly transformed and subdued it, so that it is no longer the scourge and curse of society that it was in the pre-scientific ages. We are apt to forget what we owe to science in this respect, and the horrors that modern society has escaped by getting rid of the grosser and more malignant forms of belief in ghostly supersensuous and diabolic agency. But fully to appreciate our advantages it is necessary, once in a while, to turn back and contemplate the condition of things in the ages of ignorance, when men were given over to the terrors of vicious and cruel superstitions. An admirable book has been lately published, which presents a vivid picture of the general state of mind and society a few centuries ago in Western Europe, resulting from the current belief in supernatural agencies, and we propose to cull a few statements from its pages in illustration of the subject.*

* The Magic of the Middle Ages. By Viktor Rydberg. Translated from the Swedish by August Hjalmar Edgren. New York: Henry Holt & Co.

The author first finds the theological root of his subject. During the middle ages it was held that all power or force was spiritual, that it came from a spiritual source—from God—and was communicated to the earth by spiritual agents or angels. No inevitable causation was admitted. The laws of nature were the precepts in accordance with which the angels executed the will of God. Sometimes he suspended their agency, acting everywhere himself, or he delegated unusual power to them, when their operations were known as miracles. Hence a knowledge of nature was at this time chiefly a knowledge of the angels. Lucifer, the highest of these angels, rebelled against God. The contest ended with the overthrow of the rebel and his followers; but God, calm in the consciousness of his omnipotence, determined that Lucifer, now changed by his rebellion into a spirit wholly evil, should enjoy liberty of action within certain limits. The activity of the fallen spirit consists henceforth in incessant warfare against God. Man is tempted and falls. The earth is divided into two antagonistic kingdoms, those of good and evil. Over one reigns God and his angels of light, over the other the devil and his minions. Such was the dualistic conception of the middle ages, and to it may be traced the magic of the Church, the astrology, alchemy, and sorcery of the learned, as well as the diabolic forms of witchcraft believed in by the common people.

The Church, exercising its watch-care for man, surrounded him from the cradle to the grave by the safeguards of magic. Thus, soon after the birth of the child the priest must be ready to sprinkle it with holy water, which has been purified from the pollution of demons by prayer and conjuration; and so strong was the impression that the child, begotten in sin and by nature Lucifer's property, would be doomed to the torments of hell without the grace of baptism, that certain conscientious servants of the Church attempted to devise some means by which the saving water might be brought in contact with the child before it saw the light.

Holy water, when drunk by the sick and infirm, healed and strengthened; if sprinkled upon the field it promoted fertility, and given to domestic animals it afforded them protection against witchcraft.

Says Thomas Aquinas: "It is a dogma of faith that the demons can produce wind, storms, and rain of fire from heaven. The atmosphere is a battle-field between angels and devils. The latter work the constant injury of man, the former his melioration; and the consequence is that changeableness of weather which threatens to frustrate the hopes of husbandry. And, when Lucifer is able to bestow even upon man—sorcerers and wizards—the power to destroy the fields, the vineyards, and dwellings of man by rain, hail, and lightning, is it to be wondered at if the Church, which is man's protection against the devil, and whose especial calling it is to fight him, should in this sphere also be his counterpoise, and should seek, from the treasury of its divine

power, means adequate to frustrate his atmospheric mischiefs? To these means belong the church-bells, provided they have been duly consecrated and baptized. The aspiring steeples, around which cluster the low dwellings of men, are to be likened, when the bells in them are ringing, to the hen spreading its protecting wings over its chickens; for the tones of the consecrated metal repel the demons and avert storm and lightning."

During protracted drought it was the custom for the priests to make intercession and inaugurate rain-processions, and it is narrated that, in the year 1240, in Lüttich a large rain-procession failed, three times, to produce any effect, "because, in the supplication of all saints, God's mother had been forgotten." A new procession was formed, due respect was shown her Majesty, and the rain immediately came down with such violence that the devout procession was dispersed.

If the fields were visited by destructive insects, the Church had remedies against them also. It commanded them in the name of God to depart; and, if they did not obey, regular processes were instituted against them, which ended in their excommunication by the Church. In the year 1474 the May-bug committed great depredations in the neighborhood of Berne. The authorities of the city sought relief against the scourge from the Bishop of Lausanne, who issued a letter of excommunication, which was solemnly read by a priest in the churchyard of Berne. The letter began thus: "Thou irrational, imperfect creature, thou May-bug, thou whose kind was never inclosed in Noah's ark; in the name of my gracious lord the Bishop of Lausanne, by the power of the glorified Trinity through the merits of Jesus Christ, and by the obedience you owe the Holy Church, I command you, May-bugs, all in common and each one in particular, to depart from all places where nourishment for man and cattle germinates and grows." The letter ends with a summons to the insects to present themselves at Wivelsburg on the sixth day thereafter, at one o'clock, if they do not disappear before that time, and assume the responsibility before the court of the gracious lord of Lausanne! Arrangements were made beforehand for a legal trial; the accused, of course, was to have a lawyer, and the Bishop devised the plan of summoning from hell the spirit of an infamous one named Perrodet, who had died a few years before. But, in spite of many summonses, neither Perrodet nor the May-bugs deigned to appear, and finally the episcopal tribunal gave its verdict of excommunication in the name of the Holy Trinity—"to you accursed vermin, that are called May-bugs, and which can not even be counted among the animals." The Government ordered the authorities of the afflicted district to report concerning the effects of the measure; but a chronicle of the time reports that "no effect was observed, because of our sins."

The most scrupulous attention to legal forms was given to the frequently recurring processes against May-bugs, grasshoppers, worms,

and other noxious vermin, for any neglect of these forms was supposed to deprive a judgment of its magical power. The question whether they were subject to a spiritual or legal tribunal was much agitated, but without being definitely settled. A civil prosecution of the field-rats in the Tyrol, 1519–'20, proves that sometimes such suits were decided by secular tribunals.

The peasant, Simon Fliss, made complaint to the judge, William of Hasslingen, that the field-rats were committing great depredations in his parish. The court then appointed Hans Grinebner advocate for the accused, and the plaintiff chose as his advocate Schwarz Minig. Numerous witnesses established the fact that the rats had committed great destruction, and the decision was rendered against them in the following terms: "After accusation and defense, after statement and contradiction, and after due consideration of all that pertains to justice, it is by this sentence determined that those noxious animals which are called field-rats must, within two weeks after the promulgation of this judgment, depart and for ever remain far aloof from the fields and the meadows of Stilf. But if one or several of the animals are pregnant, or unable on account of their youth to follow, then shall they enjoy, during further two weeks, safety and protection from everybody, and after these two weeks depart."

Nothing was too absurd, nothing too superstitious, for the credulity of this period. The consecrated machinery was so various and complete that, if one explanation did not serve the purpose of the Church, another could usually be found. One question, however, did not readily find an answer, namely: How are the divine miracles to be distinguished from the infernal ones? Attempts of the acutest scholastics failed to establish a rule of definite separation; for the two kinds of miracles were revealed under identical forms, and Satan could transform himself into an angel of light. The grossest doctrines received the sanction of the Church, and thus was laid the foundation of that labyrinth of superstitions among the people in the darkness of which humanity groped for a thousand years. If the miracles worked by the apostles of the Church had their source in divine agencies, then those performed by its opponents must have been instigated by the devil. The white magic stood opposed to the black, and the idea of a conscious league between the devil and man became a well-established dogma.

In the fifteenth century there came a terrible crisis. This was preceded by the trial of the Templars and by several local witch-processes with subsequent executions, until finally, December 5, 1484, the bull of Pope Innocent VIII. appeared. This, with its companion, a book called "The Witch-hammer," brought the evil to a climax. Some idea of this bull may be gathered from the following extract. The Pope begins by asserting that, as the guardian of souls, he must exercise care in promoting the growth of the Catholic faith and driving her-

esy far from the faithful. "But," he continues, "it is not without profound grief that I have learned recently that persons of both sexes, forgetting their own eternal welfare and erring from the Catholic faith, mix with devils, with *incubi* and *succubi*, and injure by witch-songs, conjurations, and other shameful practices, revelries, and crimes, the unborn children of women, the young of animals, the harvests of the fields, the grapes of the vineyards, and the fruit of the trees; that they also destroy, suffocate, and annihilate men, women, sheep and cattle, vineyards, orchards, meadows, and the like; visit men, women, cattle and other animals with internal and external pains and sickness; prevent men from procreation and women from conception, and render them entirely unfit for their mutual duties, and cause them to recant, besides, with sacrilegious lips, the very faith which they have received in baptism." The Pope therefore appoints the professors of theology, Henry Institor and Jacob Springer, to be prime inquisitors, with absolute power over all districts which are contaminated with those diseases. Finally, he proclaims that no appeal from the tribunals of the inquisitors to other courts, not even to the Pope himself, will be allowed. The inquisitors and their assistants are invested with unlimited power over life and death, and are exhorted to fulfill their commission with zeal and severity. The bull contains no directions as to how the judges should proceed in the trial of witches, but "The Witch-hammer," bearing the sanction of the Pope, is most explicit upon the subject. This book became juridical authority, and was followed even in Protestant countries until early in the eighteenth century. It begins by attempting to show that its theories are entirely founded upon the Scriptures. The history of Job, the temptation of Jesus in the desert, and the many demoniacs mentioned in the New Testament, are adduced to prove that Satan can dwell in man and use the human body as his implement. Moreover, Moses ordained that witches should be put to death, a command which would be entirely superfluous, if witches had not existed. "The Witch-hammer" then broaches the question why it is that women are especially addicted to sorcery, and devotes thirty-three pages to the proof thereof. The following is an example of its argument: The holy fathers have often said that there are three things which have no moderation in good or evil—the *tongue*, a *priest*, and a *woman*. Concerning woman this is evident. All ages have made complaints against her. The wise Solomon, who was himself tempted to idolatry by woman, has often in his writings given the feminine sex a sad but true testimonial; and the holy Chrysostom says: "What is woman but an enemy of friendship, an unavoidable punishment, a necessary evil, a natural temptation, a desirable affliction, a constantly flowing source of tears, a wicked work of nature covered with a shining varnish?" Already had the first woman entered into a sort of compact with the devil; should not, then, her daughters do it also? The very word *femina* (woman) means *one wanting in*

faith; for *fe* means "faith," and *minus* "less." Since she was formed of a crooked rib, her entire spiritual nature has been distorted and inclined more toward sin than virtue. If we here compare the words of Seneca, "Woman either loves or hates; there is no third possibility," it is easy to see that when she does not love God she must resort to the opposite extreme and hate him. It is thus clear why women especially are addicted to the practice of sorcery.

The crime of the witches exceeds all others. They are worse than the devil, for he has fallen once for all, and Christ has not suffered for him. The devil sins, therefore, only against the Creator, but the witch both against the Creator and Redeemer. The theology of the case is perfectly clear.

These and similar questions the first part of "The Witch-hammer" attempts to settle. The second part describes the various kinds and effects of witchcraft. It claims that they produce hail, thunder, and storms; they fly through the air from one place to another; they can make themselves insensible on the rack; they often subdue the judge's mind by charms and *confuse him through compassion;* they change themselves and others into cats and were-wolves; nay, they are able to enchant and kill men and beasts by their very looks. Their strongest passion is to eat the flesh of children; still they eat only unchristened children: if at any time a baptized child is taken by them, it happens by special divine concession.

Their compact with the devil may be of a private nature, or a solemn one entered into with due formalities. When the latter, it is concluded in the following manner: The witches assemble upon a day set apart by the devil. He appears in the assembly, exhorts them to faithfulness, and promises them glory, happiness, and long life. The older witches then introduce the novices, who are put to the test and take the oath of allegiance. The devil then instructs them how to prepare from the limbs of new-born babes witch-potions and witch-salves, and presents them with a powder, instructing them how to use it to the injury of men and beasts.

The witch accomplishes her voyages in the air by smearing a vessel, a broom, and a rake, a broomstick and a piece of linen, with the witch-salve; then rising she moves forth through the air, visible or invisible. "The Witch-hammer" reminds those who doubt these air-voyages that the devil carried Jesus up through the air to the pinnacle of the temple (Matthew iv. 5).

The third part of this remarkable book gives the criminal law of the witch-courts, with instructions how "sorcerers, witches, and heretics, are to be tried before spiritual as well as civil tribunals." "The Witch-hammer" states "that the trial may commence without any previous accusation." When an inquisitor comes to a place he must exhort everybody by means of proclamations nailed to the doors of churches and town-halls, and by threats of excommunication and

punishment, to give information of all persons suspected of witchcraft.

Two or three witnesses are sufficient to prove guilt. In case so many do not present themselves, the judge may find and summon them and force them to tell the truth under oath. The qualifications necessary for witnesses to possess will appear from the statement that the excommunicate, accomplices, outlawed, runaway and dissolute women, are irreproachable witnesses in cases where the faith is involved. A witch is allowed to testify against a witch, wife against husband, husband against wife, children against parents, and so on; but, if the testimonies of accomplices or relatives are to the advantage of the accused, then they are of no validity, *for blood is of course thicker than water*, and one raven does not willingly pick out the eyes of another.

An accused may have an advocate, but "The Witch-hammer" adds: "If the counselor defends his suspected client too warmly, it is right and reasonable that he should be considered as far more criminal than the sorcerer or the witch herself; that is to say, as the protector of witches and heretics he is more dangerous than the sorcerer. He should be looked upon with suspicion in the same degree as he makes a zealous defense." "The Witch-hammer" then informs the judge of five "honest and apostolic tricks" by means of which the accused and their lawyer may be confused. The quality of the questions put to the accused may be appreciated from the following examples: "Do you know that people hold you to be a witch? Why have you been observed upon the precincts of N. N.? Why have you touched N. N.'s child (or cow)? How did it happen that the child (or the cow) soon after fell sick? What was your business outside of your house when the storm broke forth? How can you explain that your cow yields three times as much milk as the cows of others?"

Before the trial of a person accused of sorcery, he was put on the rack in order that his mind might be inclined to confession. The "worst witches" were those who allowed themselves to be torn asunder, limb by limb, and their endurance is explained by the supposition that "the devil hardens them against their tortures." If confession was not wrung from the witch the first day, the torture was to be *continued* the second and third day. The civil law forbade the *repeating* of the torture. Hence the following formula used by the judge: "We ordain that the torture shall be *continued* (not *repeated*) to-morrow." The second day the instruments of torture were exhibited, and the accused was adjured, by all holy names, if innocent, to pour forth immediately abundant tears; but, if guilty, no tears at all.

If tears should flow, the judge was directed to see that it be not saliva, or other fluid; and the witch was led into the court-room backward, that the judge might see her before she saw him. Otherwise he might be moved to criminal compassion by her enchantment.

It was still further provided that the limbs of the accused should

be examined to see if they bore devil's marks. The absence of such marks, however, did not prove innocence.

With the fullest directions as to the ways and means to be adopted for the ensnaring of witches this dreadful book concludes. The effect of the fires kindled by the bull of Pope Innocent was felt far into the eighteenth century. The victims were counted by millions. Says an author of the seventeenth century, "When they had commenced in one place to burn witches, more were found in proportion as they were burned"; and it is also stated that in certain communities in Germany and France *all* the women were sent to the stake; and in many instances princes and potentates were forced, from fear of seeing their subjects exterminated, to stay by *authoritative command* the madness of the inquisitors.

No age was exempt. Children were brought to the stake with their mothers. A gloomy presentiment pervaded the community when the proclamation on the church-doors announced the arrival of the inquisitor. Work in the shops and fields ceased; and the person who had an open enemy, or suspected secret envy, knew beforehand that he was lost. And the arch-fiend was the agent and instigator of all this madness. "He was in the castle of the knight, the palaces of the mighty, the libraries of the learned, on every page of the Bible, in the churches, in the halls of justice, in the lawyer's chambers, in the laboratories of physicians and naturalists, in cottages, farm-yards, stalls, everywhere."

The popular literature of this period consisted of legends of saints and stories about the devil. There were imps, giants, trolls, forest spirits, elves, and hobgoblins on the earth; nicks, river-sprites in the water, fiends in the air, and salamanders in the fire. There were monsters such as dragons, griffins, were-wolves, witch-kind, Thor's-swine, and supernatural beings derived from the human world, but of dimmer outlines than the preceding.

Among these last was the mandragora, which was supposed to reveal to its possessor hidden things and future events, and to secure the friendship of all men. The root of the mandragora, or mandrake, often divides into two parts, and thus presents a rude resemblance to a human figure. It was believed that this plant could not be found except below the gallows where a pure youth had been hanged. When torn from the soil it was said to sigh, shriek, and moan so piteously that it caused whoever heard it to die. To find this plant it must be sought before sunrise Friday morning. The person seeking it should carefully fill his ears with cotton, wax, or pitch, and take with him a black dog, without a single white hair. The sign of the cross was to be made three times over the mandragora, then the soil was to be carefully removed, so that it was attached only by its fine rootlets. It was then tied by a string to the tail of a dog, who was attracted forward by a piece of bread. The dog pulled the plant from

the earth, but fell dead, struck by the shriek of the mandragora. The plant was then taken home, washed in red wine, and wrapped in red-and-white silk, laid in a shrine, washed on successive Fridays, and dressed in a white frock. If the mandragora is bought it remains with the person who thus secures it, regardless of where it is thrown, until sold again. If kept until death, the person must depart to hell with it.

In the demoniacal fauna of the middle ages were-wolves played an important part. They were supposed to be men who changed themselves for a time into wolves, and roved about hunting for children. Augustine, one of the most prominent of the fathers and authors of his time, taught that it was the devil who wrapped a wolf's hide around a witch. Melanchthon also believed in this doctrine, and the Emperor Sigismund had the question investigated "scientifically" in the presence of theologians, and they came to the general agreement that the were-wolf is "a positive and constant fact"; for, the existence of the devil being accepted, there is no reason to deny that of the were-wolf, supported as it is by the authority of the fathers of the Church and by general experience.

Another ghastly superstition of those times was that of belief in vampires. These were disembodied souls, which had reclothed themselves in their buried bodies. In this garb they stole at night into houses and sucked from the nipples of the sleeping their blood. The person thus bereft of his vital fluid was in turn changed into a vampire. The corpse of a person suspected of vampirism, if dug up, was found well preserved, and an abundance of fresh blood would flow from its mouth on pressing the stomach. To this horrible belief is ascribed a kind of psychical pestilence, which spread terror in the Austrian provinces even down into the eighteenth century.

We have here given only a few examples of middle-age spiritualism, and must refer the curious reader to the instructive pages of Professor Rydberg's book for the fuller presentation of this painful subject. The statements we have given may seem in the last degree ludicrous and incredible, but they imply tragic realities and an unspeakable wretchedness in the mental states where such notions could be harbored. The age that built the cathedrals of Europe was one of fanatical religious earnestness, and from this we may infer the terrible sincerity of the horrors of insane superstition by which the minds of people were darkened and poisoned.

HISTORY AND METHODS OF PALEONTOLOGICAL DISCOVERY.*

By Professor O. C. MARSH.

II.

WHILE the Paris Basin was yielding such important results for paleontology, its geological structure was being worked out with great care. The results appeared in a volume by Cuvier and Alexandre Brongniart, chiefly the work of the latter, published in 1808.† This was the first systematic investigation of Tertiary strata. Three years later, the work was issued in a more extended form. The separate formations were here carefully distinguished by their fossils, the true importance of which for this purpose being distinctly recognized. This advance was not accepted without some opposition, and it is an interesting fact that Jameson, who claimed for Werner the theory here put in practice, rejected its application, and wrote as follows: "To Cuvier and Brongniart we are indebted for much valuable information in their description of the country around Paris, but we must protest against the use they have made of fossil organic remains in their geognostical descriptions and investigations." ‡

William Smith (1769–1839), "the father of English geology," had previously published a "Tabular View of the British Strata." He appears to have arrived independently at essentially the same view as Werner in regard to the relative position of stratified rocks. He had determined that the order of succession was constant, and that the different formations might be identified at distant points by the fossils they contained. In his later works, "Strata identified by Organized Fossils," published in 1816–'20, and "Stratigraphical System of Organized Fossils," 1817, he gave to the world results of many years of careful investigations on the Secondary formations of England. In the latter work, he speaks of the success of his method in determining strata by their fossils, as follows: "My original method of tracing the strata by the organized fossils imbedded therein is thus reduced to a science not difficult to learn. Ever since the first written account of this discovery was circulated in 1799, it has been closely investigated by my scientific acquaintances in the vicinity of Bath, some of whom search the quarries of different strata in that district with as much certainty of finding the characteristic fossils of the respective rocks as if they were on the shelves of their cabinets."

The systematic study of fossils now attracted attention in England also, and was prosecuted with considerable zeal, although with less

* President's address delivered before the American Association for the Advancement of Science, at Saratoga, New York, August 28, 1879.

† "Essai sur la Géographie Mineralogique des Environs de Paris," 4to, 1808.

‡ Translation of Cuvier's discourse, Note K. (B.), p. 103, 1817.

important results than in France. An extensive work on this subject, by James Parkinson, entitled "Organic Remains of a Former World," was begun in 1804, and completed in three volumes in 1811. A second edition appeared in 1833. This work was far in advance of previous publications in England, and, being well illustrated, did much to make the collection and study of fossils popular. The belief in the geological effects of the deluge had not yet lost its power, although restricted now to the later deposits; for Parkinson, in his later edition, wrote as follows: "Why the earth was at first so constituted that the deluge should be rendered necessary—why the earth could not have been at first stored with all those substances and endued with all those properties which seemed to have proceeded from the deluge—why so many beings were created, as it appears, for the purpose of being destroyed—are questions which I presume not to answer."

William Buckland (1784–1856) published in 1823 his celebrated "Reliquiæ Diluvianæ," in which he gave the results of his own observations in regard to the animal remains found in the caves, fissures, and alluvial gravels of England. The facts presented are of great value, and the work was long a model for similar researches. Buckland's conclusions were, that none of the human remains discovered in the caves were as old as the extinct mammals found with them, and that the deluge was universal. In speaking of fossil bones found in the Himalaya Mountains, he says: "The occurrence of these bones at such an enormous elevation in the region of eternal snow, and consequently in a spot now unfrequented by such animals as the horse and deer, can, I think, be explained only by supposing them to be of antediluvian origin, and that the carcasses of the animals were drifted to their present place, and lodged in sand, by the diluvial waters."

The foundation of the "Geological Society of London," in 1807, marks an important point in the history of paleontology. To carefully collect materials for future generalizations was the object in view, and this organization gradually became the center in Great Britain for those interested in geological science. The society was incorporated in 1826, and has since been the leading organization in Europe for the advancement of the sciences within its field. The Geological Society of France, established at Paris in 1832, and the German Geological Society, founded at Berlin in 1848, have likewise contributed largely to geological investigations in these countries, and to some extent in other parts of the world. In the publications of these three societies the student of paleontology will find a mine of valuable materials for his work.

The systematic study of fossil plants may be said to date from the publication of Adolphe Brongniart's "Prodrome," in 1828.* This was very soon followed by his larger work, "Histoire des Végétaux Fos-

* "Prodrome d'une Histoire des Végétaux Fossiles," 8vo, Paris, 1828.

siles," issued in 1828–'48. Brongniart pursued the same method as Cuvier and Lamarck, viz., the comparison of fossils with living forms, and his results were of great importance. In his "Tableau des Genres Végétaux Fossiles," etc., published in Paris in 1849, he gives the classification and distribution of the genera of fossil plants, and traces out the historical progression of vegetable life on the globe, as he had done to a great extent in his previous works. He shows that the cryptogamic forms prevailed in the Primary formations, the conifers and cycads in the Secondary, and the higher forms in the Tertiary, while four fifths of living plants are exogens.

In England, Lindley and Hutton published, in 1831–'37, a valuable work in three volumes, entitled "Fossil Flora of Great Britain." This work was illustrated by many accurate plates, in which the plants of the coal formation were especially represented. Henry Witham also published two works in 1831 and 1833, in which he treated especially of the internal structure of fossil plants. "Antediluvian Phytology," by Artis, was published in London in 1838. Bowerbank's "History of the Fossil Fruits and Seeds of the London Clay" appeared in 1843. Hooker's memoir "On the Vegetation of the Carboniferous Period as compared with that of the Present Day," published in 1848, was an important contribution to the science. Bunbury, Williamson, and others, also published various papers on fossil plants. This branch of paleontology, however, attracted much less attention in England than on the Continent.

In Germany, the study of fossil plants dates back to the beginning of the century. Von Schlotheim, a pupil of Werner, published in 1804 an illustrated volume on this subject. A more important work was that of Count Sternberg, issued in 1820–'38, and illustrated with excellent plates. Cotta, in 1832, published a book with the title "Die Dendrolithen," in which he gave the results of his investigations on the inner structure of fossil plants. Von Gutbier, in 1835, and Germar, in 1844–'53, described and figured the plants of two important localities in Germany. Corda's "Beiträge zur Flora der Vorwelt," issued at Prague, in 1845, was essentially a continuation of the work of Sternberg. Unger's "Chloris Protogæa," 1841–'45, "Genera et Species Plantarum Fossilium," 1850, and his larger work, published in 1852, are all standard authorities. It the latter, the theory of descent is applied to the vegetable world. Schimper and Mougeot's "Monograph on the Fossil Plants of the Vosges," 1845, was well illustrated, and contained noteworthy results.

Göppert in 1836 published a valuable memoir entitled "Systema Filicum Fossilium," in which he made known the results of his study of fossil ferns. In the same year, this botanist began a series of experiments in which he attempted to imitate the process of fossilization, as found in nature. He steeped various animal and vegetable substances in waters holding, some calcareous, others siliceous, and others metal-

lic matter in solution. After a slow saturation, the substances were dried, and exposed to heat until the organic matters were burned. In this way Göppert successfully imitated various processes of petrifaction, and explained many things in regard to fossils that had previously been in question. His discovery of the remains of plants throughout the interior of coal did much to clear up the doubts about the formation of that substance. In 1841 Göppert published an important work in which he compared the genera of fossil plants with those now living. In 1852 another extensive work by this author appeared, entitled "Fossile Flora des Uebergangs-Gebirges."

Andræ, Braun, Dunker, Ettingshausen, Geinitz, and Goldenberg, all made notable contributions to fossil botany in Germany during the period we are now considering.

The systematic study of invertebrate fossils, so admirably begun by Lamarck, was continued actively in France. The Tertiary shells of the Seine Valley were further investigated by Defrance, and especially by Deshayes, whose great work on this subject was begun in 1824.* Des Moulins's essay on "Sphérulites" in 1826, Blainville's memoir on "Belemnites" in 1827, Férussac's various memoirs on land and fresh-water fossil shells, were valuable additions to the subject. A later work of great importance was D'Orbigny's "Paléontologie Française," 1840–'44, which described the mollusca and radiates in detail, according to formations. The other publications of this author are both numerous and valuable. Brongniart and Desmarest's "Histoire naturelle des Crustacés Fossiles," published in 1822, is a pioneer work on this subject. Michelin's memoir on the fossil corals of France, 1841–'46, was another important contribution to paleontology. Agassiz's works on fossil Echinoderms and Mollusks are valuable contributions to the science. The works of D'Archiac, Coquand, Cotteau, Desor, Edwards, Haime, and De Verneuil, are likewise of permanent value.

In Italy, Bellardi, Merian, Michellotti, Phillipi, Zigno, and others, contributed important results to paleontology.

In Belgium, Bosquet, Nyst, Koninck, Ryckholt, Van Beneden, and others have all aided materially in the progress of the science.

In England, also, invertebrate fossils were studied with care, and continued progress was made. Sowerby's "Mineral Conchology of Great Britain," in six volumes, a systematic work of great value, was published in 1812–'30, and soon after was translated into French and German. Its figures of fossil shells are excellent, and it is still a standard work. Miller's "Natural History of the Crinoidea," published at Bristol, in 1821, and Austin's later monograph, are valuable for reference. Brown's "Fossil Conchology of Britain and Ireland" appeared in 1839, and Brodie's "History of the Fossil Insects of England" in 1845. Phillips's illustration of the geology of Yorkshire, 1829–'36, and

* "Description des Coquilles Fossiles des Environs de Paris," 3 vols., Paris, 1824–'37.

his work on the Palæozoic fossils of Cornwall, Devonshire, and West Somerset, 1843, contained a great deal of original matter in regard to fossil remains. Morris's "Catalogue of British Fossils," issued in 1843, and the later edition in 1854, is most useful to the working paleontologist. The memoirs of Davidson on the Brachiopoda, Edwards, Forbes, Morris, Lycett, Sharpe, and Wood on other Mollusca, Wright on the Echinoderms, Salter on Crustacea, Busk on Polyzoa, Jones on the Entomostraca, and Duncan and Lonsdale on Corals, are of especial value. King's volume on Permian fossils, Mantell's various memoirs, Dixon's work on the fossils of Sussex, 1850, and McCoy's works on Palæozoic fossils, all deserve honorable mention. Sedgwick, Murchison, and Lyell, although their greatest services were in systematic geology, each contributed important results to the kindred science of paleontology during the period we are reviewing.

In Germany, Schlotheim's treatise, "Die Petrifactenkunde," published at Gotha in 1820, did much to promote a general interest in fossils. By far the most important work issued on this subject was the "Petrifacta Germanica," by Goldfuss, in three folio volumes, 1826–1844, which has lost little of its value. Bronn's "Geschichte der Natur," 1841–'46, was a work of great labor, and one of the most useful in the literature of this period. The author gave a list of all the known fossil species, with full references, and also their distribution through the various formations. This gave exact data on which to base generalizations, hitherto of comparatively little value.

Among other early works of interest in this department may be mentioned Dalman's memoir on "Trilobites," 1828, and Burmeister's on the same subject, 1843. Giebel's well-known "Fauna der Vorwelt," 1847–'56, gave lists of all the fossils described up to that time, and hence is a very useful work. The "Lethæa Geognostica," by Bronn, 1834–'38, and the second edition by Bronn and Roemer, 1846–'56, is a comprehensive general treatise on paleontology, and the most valuable work of the kind yet published.

The researches of Ehrenberg, in regard to the lowest forms of animals and plants, threw much light on various points in paleontology, and showed the origin of extensive deposits, the nature of which had before been in doubt. Von Buch, Barrande, Beyrich, Berendt, Dunker, Geinitz, Heer, Hörnes, Klipstein, Von Münster, Reuss, Roemer, Sandberger, Suess, Von Hagenow, Von Hauer, Zeiten, and many others, all aided in the advancement of this branch of science. Angelin, Hisinger, and Nilsson, in Scandinavia; Abich, de Waldheim, Eichwald, Keyserling, Kutorga, Nordmann, Pander, Rouillier, and Volborth, in Russia; and Pusch in Poland, published important results on fossil invertebrates.

The impetus given by Cuvier to the study of vertebrate fossils extended over Europe, and great efforts were made to continue discoveries in the direction he had so admirably pointed out.

Louis Agassiz (1807–1873), a pupil of Cuvier, and long an honored member of this association, attained eminence in the study of ancient as well as of recent life. His great work on Fossil Fishes* deserves to rank next to Cuvier's "Ossemens Fossiles." The latter contained mainly fossil mammals and reptiles, while the fishes were left without an historian till Agassiz began his investigations. His studies had admirably fitted him for the task, and his industry brought together a vast array of facts bearing on the subject. The value of this grand work consists not only in its faithful descriptions and plates, but also in the more profound results it contained. Agassiz first showed that there is a correspondence between the succession of fishes in the rocks and their embryonal development. This is now thought to be one of the strongest points in favor of evolution, although its discoverer interpreted the facts as bearing the other way.

Pander's memoirs on the fossil fishes of Russia form a worthy supplement to Agassiz's classic work. Brandt's publications are likewise of great value; and those of Lund, in Sweden, have an especial interest to Americans, in consequence of his researches in the caves of Brazil.

Croizet and Jobert's "Recherches sur les Ossemens Fossiles du Département du Puy-de-Dôme," published in 1828, contained valuable results in regard to fossil mammals. Geoffroy Saint-Hilaire's researches on fossil reptiles, published in 1831, were an important advance. De Serres and De Christol's explorations in the caverns in the south of France, published between 1829 and 1839, were of much value. Schmerling's researches in the caverns of Belgium, published in 1833–'36, were especially important on account of the discovery of human remains mingled with those of extinct animals. Deslongchamp's memoirs on fossil reptiles, 1835, are still of great interest. Pictet's general treatise on paleontology was a valuable addition to the literature, and has done much to encourage the study of fossils.† De Blainville, in his grand work, "Ostéographie," issued in 1839–'56, brought together the remains of living and extinct vertebrates, forming a series of the greatest value for study. Aymard and Pomel's contributions to vertebrate paleontology are both of value. Gervais and Lartet added much to our knowledge of the subject, and Bravard and Hébert's memoirs are well known.

The brilliant discoveries of Cuvier in the Paris Basin excited great interest in England, and, when it was found that the same Tertiary strata existed in the south of England, careful search was made for vertebrate fossils. Remains of some of the same genera described by Cuvier were soon discovered, and other extinct animals new to science were found in various parts of the kingdom. König, to whom we owe

* "Recherches sur les Poissons Fossiles," 1833–'45.

† "Traité Élémentaire de Paléontologie," etc., Geneva. 4 vols. 1844–'46, second edition, Paris, 1853–'55.

the name *Ichthyosaurus*, and Conybeare, who gave the generic designation *Plesiosaurus*, and also *Mosasaurus*, were among the earliest writers in England on fossil reptiles. The discovery of these three extinct types, and the discussion as to their nature form a most interesting chapter in the annals of paleontology. The discovery of the *Iguanodon*, by Mantell, and the *Megalosaurus*, by Buckland, excited still higher interest. These great reptiles differed much more widely from living forms than the mammals described by Cuvier, and the period in which they lived soon became known as the "age of Reptiles." The subsequent researches of these authors added largely to the existing knowledge of various extinct forms, and their writings did much to arouse public interest in the subject.

Richard Owen, a pupil of Cuvier, followed, and brought to bear upon the subject an extensive knowledge of comparative anatomy, and a wide acquaintance with existing forms. His contributions have enriched almost every department of paleontology, and of extinct vertebrates especially, he has been, since Cuvier, the chief historian. The fossil reptiles of England he has systematically described, as well as those of South Africa. The extinct Struthious birds of New Zealand he has made known to science, and accurately described in extended memoirs. His researches on the fossil mammals of Great Britain, the extinct Edentates of South America, and the ancient Marsupials of Australia, each forms an important chapter in the history of our science.

The personal researches of Falconer and Cautley in the Siwalik Hills of India brought to light a marvelous vertebrate fauna of Pliocene age. The remains thus secured were made known in their great work, "Fauna Antiqua Sivalensis," published at London in 1845. The important contributions of Egerton to our knowledge of fossil fishes, and Jardine's well-known work, "Ichnology of Annandale," also belong to this period.

The study of vertebrate fossils in Germany was prosecuted with much success during the present period. Blumenbach, the ethnologist, in several publications between 1803 and 1814, recorded valuable observations on this subject. In 1812 Sömmering gave an excellent figure of a pterodactyl, which he named and described. Goldfuss's researches on the fossil vertebrates from the caves of Germany, published in 1820–'23, made known the more important facts of that interesting fauna. His later publications on extinct amphibians and reptiles were also noteworthy. Jäger's investigations on the extinct vertebrate fauna of Würtemberg, published between 1824 and 1839, were an important advance. To Plieninger's researches in the same region, 1834–'44, we owe the discovery of the first Triassic mammal (*Microlestes*), as well as important information in regard to Labyrinthodonts. Kaup's researches on fossil mammals, 1832–'41, brought to light many interesting forms, and to him we are indebted for the

generic name *Dinotherium*, and excellent descriptions of the remains then known.

Count Münster's "Beiträge zur Petrifactenkunde," published 1843–'46, contained several valuable papers on fossil vertebrates; and the separate papers by the same author are of interest. Andreas Wagner wrote on Pterosaurians in 1837, and later gave the first description of fossil mammals of the Tertiary of Greece, 1837–'40. Johannes Müller published an important illustrated work on the Zeuglodonts in 1849, and various notable memoirs; and Quenstedt interesting descriptions of fossil reptiles, as well as other papers of much value. Rütimeyer's suggestive memoirs are widely known.

Hermann von Meyer's contributions to vertebrate paleontology are by far the most important published in Germany during the period we are now considering. From 1830 his investigations on this subject were continuous for nearly forty years, and his various publications are all of value. His "Beiträge zur Petrifactenkunde," 1831–'33, contains a series of valuable memoirs. His "Palæologica," issued in 1832, includes a synopsis of the fossil vertebrates then known, with much original matter. His great work, "Zur Fauna der Vorwelt," 1845–'60, includes a series of monographs invaluable to the student of vertebrate paleontology. This work, as well as his other chief publications, was illustrated with admirable plates from his own drawings. Other memoirs by this author will be found in the "Palæontographica," of which he was one of the editors. In the many volumes of this publication, which began in 1851, and is still continued, will be found much to interest the investigator in any branch of paleontology.

The "Palæontographical Society of London," established in 1847, has also issued a series of volumes containing valuable memoirs in various branches of paleontology. These two publications together are a storehouse of knowledge in regard to extinct forms of animal and vegetable life.

It may be interesting here to note briefly the use of general terms in paleontology, as the gradual progress of the science was indicated to some extent in its terminology. At first, and for a long time, the name "*fossil*" was appropriately used for objects dug from the earth, both minerals and organic remains. The term "oryctology," having essentially the same meaning, was also used for this branch of study. For a long period, too, the termination *ites* (λίθος, a stone) was applied to fossils to distinguish them from the corresponding living forms; as, for instance, "*ostracites*," used by Pliny. At a later date the general name "figured stones" (*lapides figurati*) was extensively used; and, less frequently, "deluge-stones" (*lapides diluviani*). The term "organized fossils" was used to distinguish fossils from minerals when the real difference became known, although the name "*reliquiæ*" was sometimes employed. The term "petrifactions" (*petrificata*) was de-

fined by John Gesner in his work on fossils in 1758, and was afterward extensively used. Paleontology is comparatively a modern term, having only come into use only within the last half century. It was introduced about 1830, and soon was generally adopted in France and England; but in Germany it met with less favor, though used to some extent.

It would be interesting, too, did time permit, to trace the various opinions and superstitions held at different times in regard to some of the more common fossils, for example the Ammonite or the Belemnite—of their supposed celestial origin; of their use as medicine by the ancients, and in the East to-day; of their marvelous power as charms among the Romans, and still among the American Indians. It would be instructive, also, to compare the various views expressed by students in science concerning some of the stranger extinct forms—for instance, the Nummulites, among Protozoa; the Rudistes, among Mollusks; or the Mosasaurus, among reptiles. Dissimilar as such views were, they indicate in many cases gropings after truth—natural steps in the increase of knowledge.

The third period in the history of paleontology, which, as I have said, began with Cuvier and Lamarck at the beginning of the present century, forms a natural epoch extending through six decades. The definite characteristics of this period, as stated, were dominant during all this time, and the progress of paleontology was commensurate with that of intelligence and culture.

For the first half of this period, the marvelous discoveries in the Paris Basin excited astonishment and absorbed attention; but the real significance and value of the facts made known by Cuvier, Lamarck, and William Smith were not appreciated. There was still a strong tendency to regard fossils merely as interesting objects of natural history, as in the previous period, and not as the key to profounder problems in the earth's history. Many prominent geologists were still endeavoring to identify formations in different countries by their mineral characters rather than by the fossils imbedded in them. Such names as "Old Red Sandstone" and "New Red Sandstone" were given in accordance with this opinion. Humboldt, for example, attempted to compare the formations of South America and Europe by their mineral features, and doubted the value of fossils for this purpose. In 1823 he wrote as follows: "Are we justified in concluding that all formations are characterized by particular species? that the fossil shells of the chalk, the muschelkalk, the Jura limestone, and the Alpine limestones are all different? I think this would be pushing the induction much too far." * Jameson still thought minerals more important than fossils for characterizing formations; while Bakewell, later yet, defines paleontology as comprising "fossil zoölogy and fossil

* "Essai Géognostique sur le Gisement des Roches," p. 41.

botany, a knowledge of which may appear to the student as having little connection with geology."

During the later half of the third period, greater progress was made, and before its close geology was thoroughly established as a science. Let us consider for a moment what had really been accomplished up to this time.

It had now been proved beyond question that portions at least of the earth's surface had been covered many times by the sea, with alternations of fresh water and of land; that the strata thus deposited were formed in succession, the lowest of the series being the oldest; that a distinct succession of animals and plants had inhabited the earth during the different geological periods; and that the order of succession found in one part of the earth was essentially the same in all. More than 30,000 new species of extinct animals and plants had now been described. It had been found, too, that from the oldest formations to the most recent, there had been an advance in the grade of life, both animal and vegetable, the oldest forms being among the simplest, and the higher forms successively making their appearance.

It had now become clearly evident, moreover, that the fossils from the older formations were all extinct species, and that only in the most recent deposits were there remains of forms still living. The equally important fact had been established that in several groups of both animals and plants the extinct forms were vastly more numerous than the living, while several orders of fossil animals had no representatives in modern times. Human remains had been found mingled with those of extinct animals, but the association was regarded as an accidental one by the authorities in science; and the very recent appearance of man on the earth was not seriously questioned. Another important conclusion reached, mainly through the labors of Lyell, was, that the earth had not been subjected in the past to sudden and violent revolutions; but the great changes wrought had been gradual, differing in no essential respect from those still in progress. Strangely enough, the corollary to this proposition, that life, too, had been continuous on the earth, formed at that date no part of the common stock of knowledge.

In the physical world the great law of "correlation of forces" had been announced and widely accepted; but, in the organic world, the dogma of the miraculous creation of each separate species still held sway, almost as completely as when Linnæus declared, "There are as many different species as there were different forms created in the beginning by the Infinite Being." But the dawn of a new era was already breaking, and the third period of paleontology we may consider now at an end.

Just twenty years ago, science had reached a point when the belief in "special creations" was undermined by well-established facts, slowly

accumulated. The time was ripe. Many naturalists were working at the problem, convinced that evolution was the key to the present and the past. But how had Nature brought this change about? While others pondered, Darwin spoke the magic words—"*natural selection*," and a new epoch in science began.

The fourth period in the history of paleontology dates from this time, and is the period of to-day. One of the main characteristics of this epoch is the belief that *all life, living and extinct, has been evolved from simple forms.* Another prominent feature is the accepted fact of *the great antiquity of the human race.* These are quite sufficient to distinguish this period sharply from those that preceded it.

The publication of Charles Darwin's work on the "Origin of Species," November, 1859, at once aroused attention, and started a revolution which has already in the short space of two decades changed the whole course of scientific thought. The theory of "natural selection," or, as Spencer has happily termed it, the "survival of the fittest," had been worked out independently by Wallace, who justly shares the honor of the discovery. We have seen that the theory of evolution was proposed and advocated by Lamarck, but he was before his time. The anonymous author of the "Vestiges of Creation," which appeared in 1844, advocated a somewhat similar theory, which attracted much attention, but the belief that species were immutable was not sensibly affected until Darwin's work appeared.

The difference between Lamarck and Darwin is essentially this: Lamarck proposed the theory of evolution; Darwin changed this into a doctrine, which is now guiding the investigations in all departments of biology. Lamarck failed to realize the importance of time, and the interaction of life on life. Darwin, by combining these influences with those also suggested by Lamarck, has shown *how* the existing forms on the earth may have been derived from those of the past.

This revolution has influenced paleontology as extensively as any other department of science, and hence the new period we are discussing. In the last epoch, species were represented independently, by parallel lines; in the present period, they are indicated by dependent, branching lines. The former was the analytic, the latter is the synthetic period. To-day, the animals and plants now living are believed to be genetically connected with those of the distant past; and the paleontologist no longer deems species of the first importance, but seeks for relationships and genealogies, connecting the past with the present. Working in this spirit, and with such a method, the advance during the last decade has been great, and is an earnest of what is yet to come.

The progress of paleontology in Great Britain during the present period has been great, and the general interest in the science much extended. The views of Darwin soon found acceptance here. Next

to his discovery of "natural selection," Darwin was fortunate in having so able and bold an expounder as Huxley, who was one of the first to adopt his theory and give it a vigorous support. Huxley's masterly researches have been of great benefit to all departments of biology, and his contributions to paleontology are invaluable. Among the latter, his original investigations on the relations of birds and reptiles are especially noteworthy. His various memoirs on extinct reptiles, amphibians, and fishes belong to the permanent literature of the subject. The important researches of Owen on the fossil vertebrates have been continued to the present time. He has added largely to his previous publications on the British fossil reptiles, birds, and mammals, the extinct reptiles of South Africa, and the post-Tertiary birds of New Zealand. His description of the *Archæopteryx*, near the beginning of the period, was a most welcome contribution.

The investigations of Egerton on fossil fishes have likewise been continued with important results. Busk, Dawkins, Flower, and Sanford have made valuable contributions to the history of fossil mammals. Bell, Günther, Hulke, Lankester, Newton, Powrie, Miall, Traquair, and Seely have made notable additions to our knowledge of reptiles, amphibians, and fishes. Among invertebrates, the Crustacea have been especially studied by Jones, Salter, and Woodward. Davidson, Etheridge, Lycett, Morris, Phillips, Wood, and Wright have continued their researches on the mollusks; Duncan, Nicholson, and others have investigated the extinct corals; and Binney, Carruthers, and Williamson the fossil plants. Numerous other important contributions have been made to the science in Great Britain during the present period.

On the Continent the advance in paleontology has, during the last two decades, been equally great. In France, Gervais continued his memoirs on extinct vertebrates nearly to the present date; while Gaudry has published several volumes on the subject that are models for all students of the science. His work on the fossil animals of Greece is a perfect monograph of its kind, and his later publications are all of importance. Lartet's various works are of permanent value, and his application of paleontology to archæology brought notable results. The volume of Alphonse Milne-Edwards on fossil Crustacea was a fit supplement to Brongniart and Desmarest's well-known work; while his grand memoir on fossil birds deserves to rank with the classic volumes of Cuvier. Duvernoy, Filhol, Hébert, Sauvage, and others have also published interesting results on fossil vertebrates.

Van Beneden's researches on the fossil vertebrates of Belgium have produced results of great value. Pictet, Rütimeyer, and Wiedersheim in Switzerland; Bianconi, Carnalia, Forsyth-Major, and Sismonda in Italy; and Nodot in Spain, have likewise published important memoirs. The extinct vertebrates have been studied in Germany by Von Meyer, Carus, Fraas, Giebel, Heckel, Haase, Hensel, Kayser,

Kner, Ludwig, Peters, Portis, Maack, Salenka, Zittel, and many others; in Holland by Winkler; in Denmark by Reinhardt; and in Russia by Brandt and Kowalewsky.

The fossil invertebrates have been investigated with care by D'Archiac, D'Orbigny, Bayle, Fromentel, Oustalet, and others in France; Desor, Loriol, Mayer, Ooster, and Roux in Switzerland; Capellini, Massalongo, Michellotti, Meneghini, and Sismonda in Italy; Barrande, Benecke, Beyrich, Dames, Dorn, Ehlers, Geinitz, Giebel, Gümbel, Feistmantel, Hagen, Von Hauer, Von Heyden, Von Fritsch, Laube, Oppel, Quenstedt, Roemer, Schlüter, Suess, Speyer, and Zittel in Germany. The fossil plants have been studied in these countries by Massalongo, Saporta, Zigno, Fiedler, Goldenberg, Gehler, Heer, Göppert, Ludwig, Schimper, Schenk, and many others.

Among the recent researches in paleontology in other regions may be mentioned those of Blanford, Feistmantel, Lydekker, and Stoliczka in India; Haast and Hector in New Zealand; and Krefft and McCoy in Australia—all of whom have published valuable results.

Of the progress of paleontology in America I have thus far said nothing, and I need now say but little, as many of you are doubtless familiar with its main features. During the first and second periods in the history of paleontology, as I have defined them, America, for most excellent reasons, took no part. In the present century, during the third period, appear the names of Bigsby, Green, Morton, Mitchell, Rafinesque, Say, and Troost, all of whom deserve mention. More recently the researches of Conrad, Dana, Deane, DeKay, Emmons, Gibbes, Hitchcock, Holmes, Lea, McChesney, Owen, Redfield, Rogers, Rominger, Shumard, Swallow, and many others have enlarged our knowledge of the fossils of this country.

The contributions of James Hall to the invertebrate paleontology of this country form the basis of our present knowledge of the subject. The extensive labors of Meek in the same department are likewise entitled to great credit, and will form an important chapter in the history of the science. The memoirs of Billings, Gabb, Scudder, White, and Whitfield are numerous and important; and the publications of Derby, Hartt, Hyatt, James, Miller, Shaler, Rathbun, Vogdes, Whiteaves, and Winchell, are also of value. To Dawson, Lesquereux, and Newberry we mainly owe our present knowledge of the fossil plants of this country.

The foundation of our vertebrate paleontology was laid by Leidy, whose contributions have enriched nearly every department of the subject. The numerous publications of Cope are well known. Agassiz, Allen, Baird, Dawson, Deane, DeKay, Emmons, Gibbes, Harlan, Hitchcock, Jefferson, Lea, Le Conte, Newberry, Redfield, St. John, Warren, Whitney, Worthen, Wyman, and others have all added to our knowledge of American fossil vertebrates. The chief results in

this department of our subject I have already laid before you on a previous occasion, and hence need not dwell upon them here.

In this rapid sketch of the history of paleontology I have thought it best to speak of the earlier periods more in detail, as they are less generally known, and especially as they indicate the growth of the science, and the obstacles it had to surmount. With the present work in paleontology, moreover, you are all more or less familiar, as the results are now part of the current literature. To assign every important discovery to its author would have led me far beyond my present plan. I have only endeavored to indicate the growth of the science by citing the more prominent works that mark its progress, or illustrate the prevailing opinions and state of knowledge at the time they were written.

In considering what has been accomplished, directly or indirectly, it is well to bear in mind that without paleontology there would have been no science of geology. The latter science originated from the study of fossils, and not the reverse, as generally supposed. Paleontology, therefore, is not a mere branch of geology, but the foundation on which that science mainly rests. This fact is a sufficient excuse, if one were wanting, for noting the early opinions in regard to the changes of the earth's surface, as these changes were first studied to explain the position of fossils. The investigation of the latter first led to theories of the earth's formation, and thus to geology. When speculation replaced observation, fossils were discarded, and for a time the mineral characters of strata were thought to be the key to their position and age. For some time after this, geologists, as we have seen, apologized for using fossils to determine formations, but for the last half century their value for this purpose has been fully recognized.

The services which paleontology has rendered to botany and zoölogy are less easy to estimate, but are very extensive. The classification of these sciences has been rendered much more complete by the intercalation of many intermediate forms. The probable origin of various living species has been indicated by the genealogies suggested by extinct types; while our knowledge of the geographical distribution of animals and plants at the present day has been greatly improved by the facts brought out in regard to the former distribution of life on the globe.

Among the vast number of new species which have been added are the representatives of a number of new orders entirely unknown among living forms. The distribution of these extinct orders among the different classes is interesting, as they are mainly confined to the higher groups. Among the fossil plants no new orders have yet been found. There are none known among the Protozoa or the Mollusca. The Radiates have been enriched by the extinct orders of Blastoidea,

Cystidea, and Edrioasterida; and the Crustaceans by the Eurypterida and Trilobita. Among the vertebrates, no extinct order of fossil fishes has yet been found; but the amphibians have been enlarged by the important order Labyrinthodonta. The greatest additions have been among the reptiles, where the majority of the orders are extinct. Here we have at the present date the Ichthyosauria, Sauranodontia, Plesiosauria, and Mosasauria, among the marine forms; the Pterosauria, including the Pteranodontia, containing the flying forms; and the Dinosauria, including the Sauropoda—the giants among reptiles; likewise the Dicynodontia, and probably the Theriodontia, among the terrestrial forms. Although but few fossil birds have been found below the Tertiary, we have already among the Mesozoic forms three new orders: the Saururæ, represented by *Archæopteryx;* the Odontotormæ, with *Ichthyornis* as the type; and the Odontolcæ, based upon *Hesperornis;* all of these orders being included in the sub-class Odontornithes, or toothed birds. Among mammals, the new groups regarded as orders are the Toxodontia and the Dinocerata, among the Ungulates; and the Tillodontia, including strange Eocene mammals whose exact affinities are yet to be determined.

Among the important results in vertebrate paleontology, are the genealogies, made out with considerable probability, for various existing animals. Many of the larger mammals have been traced back through allied forms in a closely connected series to early Tertiary times. In several cases the series are so complete that there can be little doubt that the line of descent has been established. The evolution of the horse, for example, is to-day demonstrated by the specimens now known. The demonstration in one case stands for all. The evidence in favor of the genealogy of the horse now rests on the same foundation as the proof that any fossil bone once formed part of the skeleton of a living animal. A special creation of a single bone is as probable as the special creation of a single species. The method of the paleontologist in the investigation of the one is the method for the other. The only choice lies between *natural derivation* and *supernatural creation.*

For such reasons it is now regarded among the active workers in science as a waste of time to discuss the truth of evolution. The battle on this point has been fought and won.

The geographical distribution of animals and plants, as well as their migrations, has received much new light from paleontology. The fossils found in some natural divisions of the earth are related so closely to the forms now living there, that a genetic connection between them can hardly be doubted. The extinct Marsupials of Australia and the Edentates of South America are well-known examples. The Pliocene hippopotami of Asia and the south of Eu-

rope point directly to migrations from Africa. Other similar examples are numerous. The fossil plants of the Arctic region prove the existence of a climate there far milder than at present, and recent researches at least render more probable the suggestion, made long ago by Buffon, in his "Epochs of Nature," that life began in the polar regions, and by successive migrations from them the continents were peopled.

The great services which comparative anatomy rendered to paleontology at the hands of Cuvier, Agassiz, Owen, and others have been amply repaid. The solution of some of the most difficult problems in anatomy has received scarcely less aid from the extinct forms discovered than from embryology; and the two lines of research supplement each other. Our present knowledge of the vertebrate skull, the limb-arches, and the limbs, has been much enlarged by researches in paleontology. On the other hand, the recent labors of Gegenbaur, Huxley, Parker, Balfour, and Thacher will make clear many obscure points in ancient life.

One of the important results of recent paleontological research is the law of brain-growth, found to exist among extinct mammals, and to some extent in other vertebrates. According to this law, as I have briefly stated it elsewhere, "all Tertiary mammals had small brains. There was, also, a gradual increase in the size of the brain during this period. This increase was confined mainly to the cerebral hemispheres, or higher portions of the brain. In some groups, the convolutions of the brain have gradually become more complicated. In some, the cerebellum and the olfactory lobes have even diminished in size." More recent researches render it probable that the same general law of brain-growth holds good for birds and reptiles from the Mesozoic to the present time. The Cretaceous birds, that have been investigated with reference to this point, had brains only about one third as large in proportion as those nearest allied among living species. The Dinosaurs from our Western Jurassic follow the same law, and had brain-cavities vastly smaller than any existing reptiles. Many other facts point in the same direction, and indicate that the general law will hold good for all extinct vertebrates.

Paleontology has rendered great service to the more recent science of archæology. At the beginning of the present period, a reëxamination of the evidence in regard to the antiquity of the human race was going on, and important results were soon attained. Evidence in favor of the presence of man on the earth at a period far earlier than the accepted chronology of six thousand years would imply, had been gradually accumulating, but had been rejected from time to time by the highest authorities. In 1823, Cuvier, Brongniart, and Buckland, and later, Lyell, refused to admit that human relics, and the bones of extinct animals found with them, were of the same geological age,

although experienced geologists, such as Boué and others, had been convinced by collecting them. Christol, Serres, and Tournal, in France, and Schmerling in Belgium, had found human remains in caves, associated closely with those of various extinct mammals, and other similar facts were on record.

Boucher de Perthes, in 1841, began to collect stone implements in the gravels of the valley of the Somme, and in 1847 published the first volume of his "Antiquités Celtiques." In this work he described the specimens he had found, and asserted their great antiquity. The facts as presented, however, were not generally accepted. Twelve years later, Falconer, Evans, and Prestwich examined the same localities with care, became convinced, and the results were published in 1859 and 1860. About the same time, Gaudry, Hébert, and Desnoyers also explored this valley, and announced that the stone implements there were as ancient as the mammoth and rhinoceros found with them. Explorations in the Swiss lakes and in the Danish shell-heaps added new testimony bearing in the same direction. In 1863 appeared Lyell's work on the "Geological Evidences of the Antiquity of Man," in which facts were brought together from various parts of the world, proving beyond question the great age of the human race.

The additional proof since brought to light has been extensive, and is still rapidly increasing. The Quaternary age of man is now generally accepted. Attempts have recently been made to approximate in years the time of man's first appearance on the earth. One high authority has estimated the antiquity of man merely to the last glacial epoch of Europe as 200,000 years; and those best qualified to judge would, I think, regard this as a fair estimate.

Important evidence has likewise been adduced of man's existence in the Tertiary, both in Europe and America. The evidence to-day is in favor of the presence of man in the Pliocene of this country. The proof offered on this point by Professor J. D. Whitney in his recent work* is so strong, and his careful, conscientious method of investigation so well known, that his conclusions seem irresistible. Whether the Pliocene strata he has explored so fully on the Pacific coast corresponds strictly with the deposits which bear this name in Europe, may be a question requiring further consideration. At present, the known facts indicate that the American beds containing human remains and works of man are as old as the Pliocene of Europe. The existence of man in the Tertiary period seems now fairly established.

In looking back over the history of paleontology, much seems to have been accomplished; and yet the work has but just begun. A small fraction only of the earth's surface has been examined, and two large continents are waiting to be explored. The "imperfection of the geological record," so often cited by friends and foes, still remains,

* "Auriferous Gravels of the Sierra Nevada of California," 1879.

although much improved; but the future is full of promise. In filling out this record, America, I believe, will do her full share, and thus aid in the solution of the great problems now before us.

I have endeavored to define clearly the different periods in the history of paleontology. If I may venture, in conclusion, to characterize the present period in all departments of science, its main feature would be a *belief in universal laws.* The reign of Law, first recognized in the physical world, has now been extended to Life as well. In return, Life has given to inanimate Nature the key to her profounder mysteries—Evolution, which embraces the universe.

What is to be the main characteristic of the next period? No one now can tell. But, if we are permitted to continue in imagination the rapidly converging lines of research pursued to-day, they seem to meet at the point where organic and inorganic nature become one. That this point will yet be reached, I can not doubt.

INTEROCEANIC CANAL ROUTES.*

By CHARLES DE FOURCY, C. E.

INSTEAD of delaying the discussion by a series of resolutions, I ask your permission to develop, at some length, the question as it strikes me in its entirety; and, that you may know the drift of my argument, I will begin by stating the conclusion at which I have arrived, viz., that the Interoceanic Canal should be constructed in the Isthmus of Panama, between the Bay of Colon and the Gulf of Panama. This canal, using merely the water of the ocean, should have no appreciable current, and it should be of the same level as the average tide in the Bay of Colon, where the rise and fall are hardly perceptible. To show you why I am firmly convinced of this, I will enter with some detail into the labors of your second sub-committee, over which I had the honor of presiding, and of which you warmly received the report presented by M. Voisin Bey. The report of this sub-committee, which is to be printed, will show you how impartially, with what scrupulous care, with what exhaustive discussion, and finally with what unanimity its decisions were taken. I am wrong in saying *decisions*, for none were taken. Of every one of the plans submitted then to its examination, and now to your vote, it showed up the advantages and the difficulties, the strong and the weak side; it prepared no form of resolution, giving to each of its members full liberty to express an opinion, as you can now. It is therefore in my personal name

* The Interoceanic Canal. Speech delivered by M. Charles de Fourcy before the Technique Committee of the Paris International Congress, on May 28, 1879.

and on my own responsibility that I offer you my solution and the following explanations.

I shall examine successively the various plans for lock-canals, showing which one seems to me to be the best, if such a system should be regarded as most advantageous.

I shall compare, in the same way, the projects for a tide-level canal. Finally, I shall compare the best plan for a lock canal with the best one for a tide-level canal.

[PRINCIPAL PROJECTED ROUTES OF THE INTEROCEANIC CANAL EXAMINED BY THE INTERNATIONAL CONGRESS. (See map on the following page.)

1. *Plan by the Isthmus of Tehuantepec.* Length, 148 miles; number of locks, 120; time for passage, twelve days.

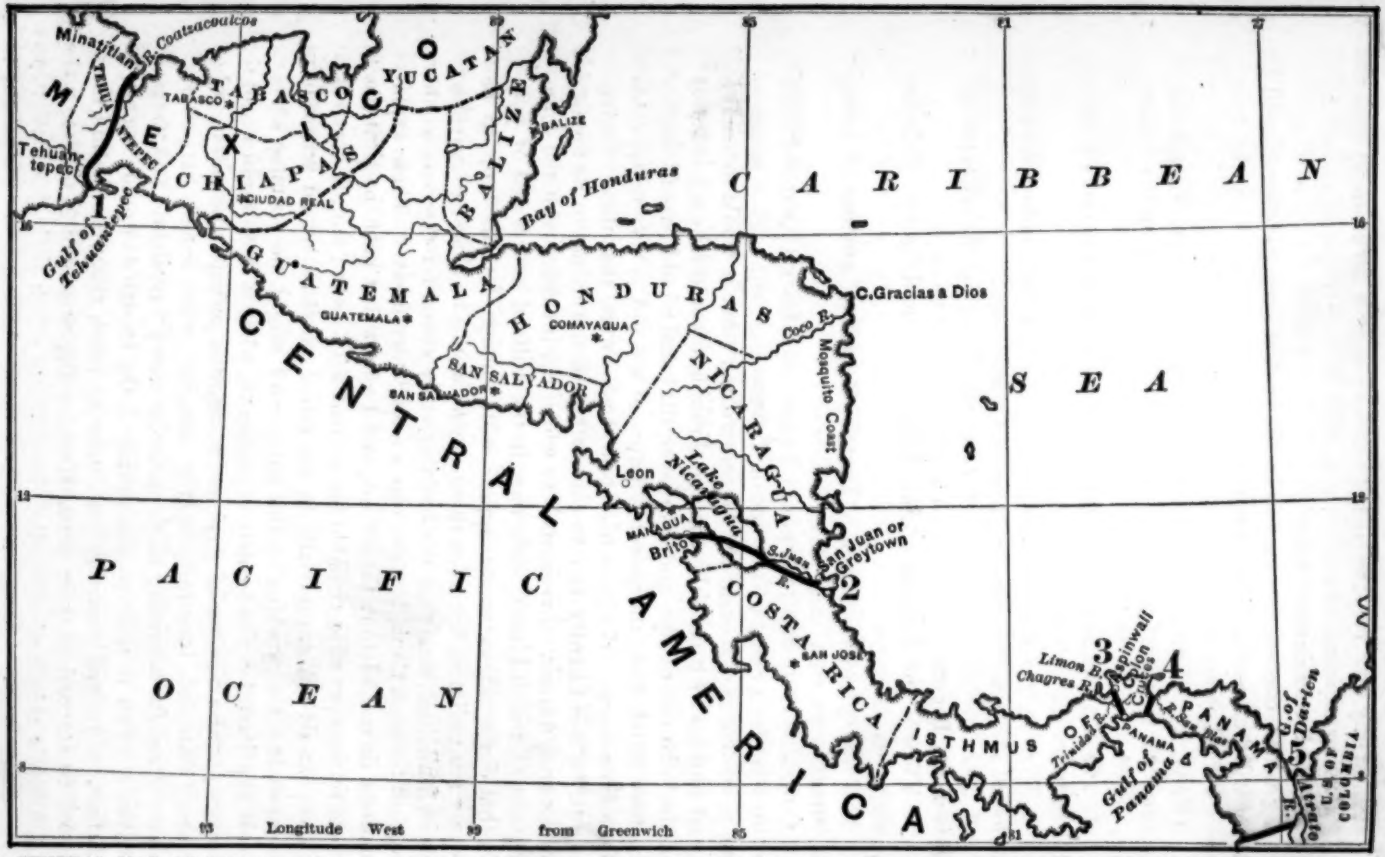
2. *Plan by the Lake of Nicaragua.* Length, 180 miles; number of locks, 17; time for passage, four and a half days.

3. *Plan for Level-water and Deep-cut Canal by the Isthmus of Panama.* Length, 45 miles; time for passage, two days.

4. *Plan by the Isthmus of San Blas.* Length, 33 miles; time for passage, one day.

5. *Plan by Atrato-Napipi.* Length, 179 miles; number of locks, 3; time for passage, three days.—EDITOR.]

COMPARISON OF THE DIFFERENT PLANS FOR A LOCK-CANAL.—I shall at once refuse a canal by the line of Tehuantepec, although it seems to me to be one of the easiest to be constructed: but it would demand a great number of locks; the passage through it would take a great deal of time comparatively; and, moreover, the canal would pass through a country which, from the unstable nature of the soil, is very undesirable for such a work. We have been told, I am aware, that these "movements," which I hardly dare to call earthquakes, were not to be feared; that during these "movements," to which the inhabitants of the country are well accustomed, sometimes in the walls of houses and of public buildings, cracks would appear wide enough for the light to be seen through them, but soon these cracks would be closed to crevices, mere lines, and that then the buildings threatened for the time would again become solid until there was a new "movement." These explanations do not entirely satisfy me, and I admit that such possibilities seem to me very objectionable for a canal with locks; simple crevices in the lateral walls, especially in the raised portions, would seriously compromise the working of the gates, and might necessitate, when least expected, long and costly repairs, and, what is more serious still, interrupt for a number of days, entire months perhaps, the passage of ships. Can one, therefore, readily imagine what would happen if fleets of vessels, becoming more numerous every day, should find themselves stopped in their passage, some on the Pacific and others on the Atlantic side, and compelled, in order to reach their destination, to continue their journey by Cape Horn or the Straits of Magellan, to



A GENERAL MAP OF THE ISTHMUS OF CENTRAL AMERICA, SHOWING THE VARIOUS PROJECTED ROUTES FOR THE INTEROCEANIC CANAL.

which they were no longer accustomed? What would then become of the insurance which had been arranged for the expected passage through a canal which was no longer of any use?

If, in speaking of Tehuantepec, which line, however, is no longer thought of for a canal, I have somewhat enlarged on the inconveniences which would arise from earthquakes, it is because they also appear to me to apply to the canal by Nicaragua, and to put it out of consideration, even were there no other reasons.

Let us look, all the same, at other contingencies which are noticeable at Nicaragua.

It would be a long and difficult task to actually begin the work, because, before the great dockyards of the canal could be built, it would be necessary to make a harbor at Greytown, the success of which does not appear to be assured, and which at any rate would be very expensive.

Starting at this harbor, the canal, when leaving the San Juan River, would for several kilometres be suspended over the valley by immense dikes holding continuously a weight of water 8·50 metres high. There the slightest leak would become a breach, any breach a serious rupture, and any rupture a complete disaster. At what possible expense could the absolute security of these great dikes be assured?

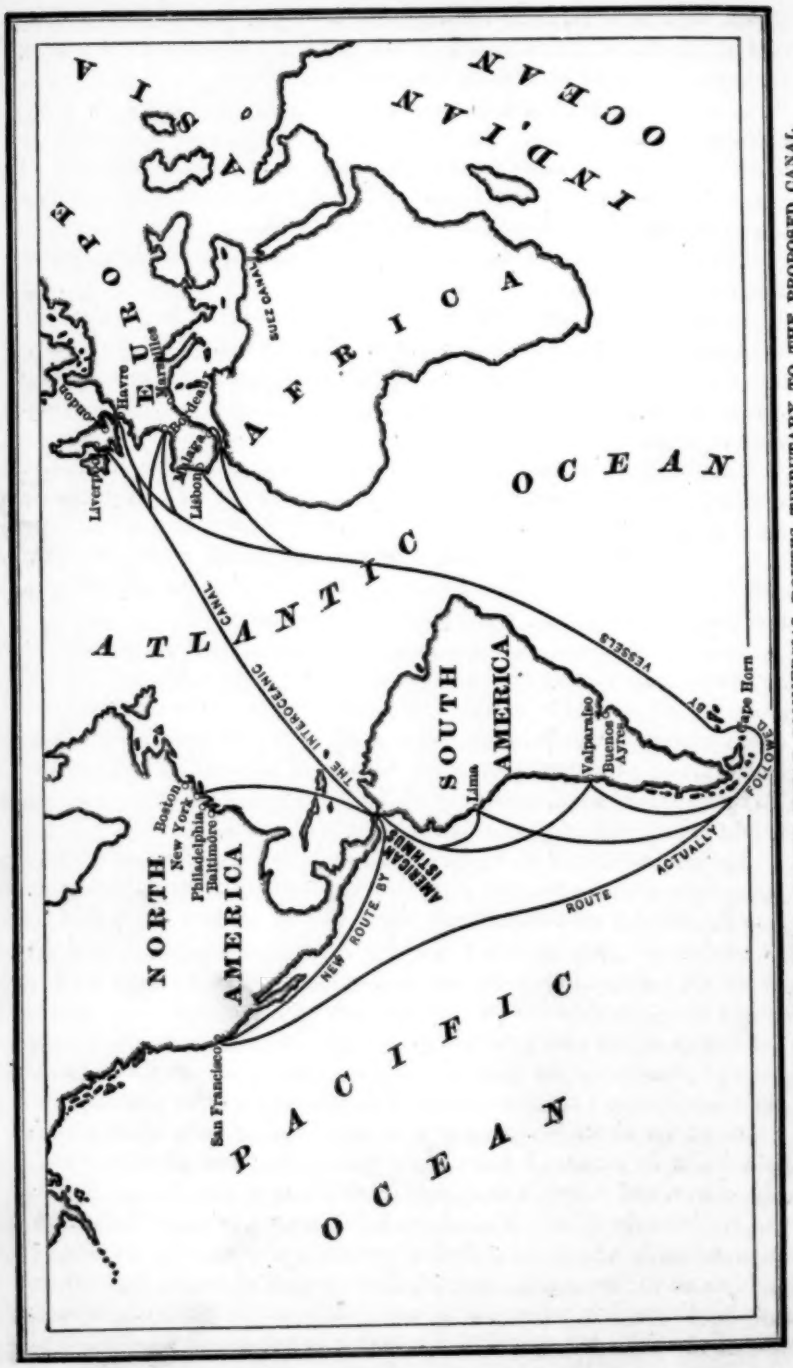
To continue: we enter the San Juan River, kept in bounds by a large dam, which, however, is not enough to assure everywhere sufficient depth of water in the shallowest parts; where there is not depth enough it would be necessary to blow up or excavate by dredges a channel one hundred metres wide by eight and a half metres deep. To make this channel would be difficult, to maintain it against what would constantly come in to fill it up might be still more so.

Let us go on until we reach the lake; here comes another difficulty. At the place where the San Juan leaves it, other torrents bring sand into it, and also mud to a considerable extent. A new bar would have to be dredged, but probably only for a time; a channel would have to be kept open in an immense sliding sand-bank by very long and costly dikes, an objection which does not seem to have been provided for in any of the plans offered.

The passage of the lake seems easy; the cut to be made to reach the Pacific offers no remarkable difficulties; but this descent, on account of its short length, can only be done by locks close together, and locks so arranged offer for a quick movement of vessels serious objections, and necessitate a considerable loss of time.

Without dwelling too much on this subject, let us be content to take as an example the Caledonian Canal. In visiting it some years ago, as an engineer and a tourist, I was struck at seeing that, to avoid passing through it, a reshipment was considered preferable. I have said enough to show my reasons for refusing to accept the Nicaragua plan.

Next comes the project by Panama with locks. Here, as if



A MAP OF THE WORLD, SHOWING THE GREAT COMMERCIAL ROUTES TRIBUTARY TO THE PROPOSED CANAL.

Nature herself had wished to get ready for man's work, the soil, as at Darien, has for a long time been free from earthquakes. The study for a lock-canal was made in 1845 by Garella, Engineer-in-Chief of Mines, sent there on a mission by the French Government. I desire to bring to your attention this name, which has been too much forgotten, because this mission, courageously and conscientiously performed, honors not only the man who carried it out, but also the administration which confided it to him, and because his splendid studies seem still to be the best that have been made there, and which should now be taken, in part at least, if it should be desirable to connect the two oceans by a lock-canal.

Condensing this too long *exposé* of the situation, I conclude by saying that, of all the lock-canals studied or proposed, the least objectionable is that which would go from the Bay of Limon to the Gulf of Panama.*

Comparison of the Tide-level Canals.—Let us now examine the different plans for level-water canals which have been presented to our consideration.

The one which is called Atrato-Napipi would have our entire sympathy if we could thus adequately express our appreciation of the devotion of Commander Selfridge, who for several years has been exploring that part of the country, so wild and difficult of access; and yet, interesting as this plan seems to be, we must absolutely refuse to accept it.

The Atrato is neither the Mississippi nor the Amazon, but it is, nevertheless, a very powerful river, with heavy overflows, which bring to its mouth immense deposits, forming a great bar. To make artificially across this bar, and to keep it always open, a channel wide enough and deep enough for the largest vessels, is a very great undertaking, the success of which, however, should not be regarded as impossible or even as improbable. But still there is no instance of a work of such importance, and we find ourselves facing a problem the solution of which—a very laborious and very expensive matter—is by no means certain.

With such an obstacle before us, and with no certainty of overcoming it, would it be prudent to undertake a canal, the expense of which is estimated at more than eleven hundred million francs?

On the other hand, the canal, properly considered, would be on the Pacific side a branch of the Atrato, and, to a great degree, unless it was entirely shut off by a sluice-gate, subjected to the variations of the Atrato. Would it be, moreover, easy to keep up, where it branches from the river, a channel with a depth always assured of eight and a half metres? Would not the point of branching, under any circumstances, be liable to be filled up with sand, which doubtless it would be difficult and expensive to keep continually removed?

* This also is the plan recommended by General Totten.

While keeping honorably the name of Commander Selfridge in our thoughts, with all regret we must put out of sight a plan the success of which is at best doubtful, while its cost would be relatively enormous.

Shall we now take up the San Blas project? This line is the shortest which joins the two oceans, but to carry it out a harbor must be built on the Atlantic, and then you soon find yourself facing a mountain-chain which has to be passed by a tunnel sixteen kilometres long; next you come to the Bayano, with elbows in its course too square to be straightened out, and a bar also on the Pacific side, which it is not certain could be mastered. The expense calculated for all this is fourteen hundred million francs.

The plan of a tunnel does not frighten M. Favre,* the contractor of the one through the St. Gothard Mountain, nor would it frighten me, especially if he were willing to undertake it; but shipmasters do not take kindly to so long a passage without fresh air and the light of day; and, although it is proposed to give electric light instead, which will be as bright as day, there would still be an unconquerable antipathy against this project.

For these reasons I decline to accept the San Blas plan, which, moreover, has only been hastily surveyed, and it is possible that a more careful examination of it would bring to light other difficulties of which we are not now cognizant.

Therefore, throwing out other plans, we find ourselves in a position to examine the project of a tide-level canal from Colon (Aspinwall) to Panama, a project which has been so patiently and courageously explored and worked out by Messrs. Wyse and Reclus, lieutenants of the French navy.

This plan demands two changes, important and absolutely necessary, the success of which, while not easy, seems to me perfectly certain.

In the first place, a large part of the ship-canal must be made in the valley of the river Chagres, a river so inconvenient and dangerous that we must have nothing to do with it, at no matter what cost, if we desire that the canal should have a regular water-level—a condition absolutely necessary for its success.

For this, two plans offer themselves. The first is to keep the canal above any possibilities of overflow. Theoretically, nothing is easier; the railroad, now in operation between Colon (Aspinwall) and Panama, which the canal should follow, and as near as possible, is above the overflow of the Chagres. By prolonging the level of this roadway to the sides of the valley a winding line would be traced, bringing us to the place beyond which the canal can be constructed, without danger from

* This great engineer died at his post in the St. Gothard Tunnel, from a stroke of apoplexy, a short time after the adjournment of the Paris Congress, of which he was one of the most valued members.

the highest overflow of the water; but this line will, doubtless, be too tortuous to enable one to follow it correctly, or to be always above it; one should, in order to obtain reasonably straight lines, or curves not too sharp, bring the canal partially to the *Thalweg* of the valley; it will therefore be necessary at several places to change the bed of the Chagres, the bends of which multiplied would encroach upon the route of the canal. But the land, coming from this partial changing of the line, as well as that which would come from digging out the canal itself, turned up to a moderate height, quite equal to the corresponding height of the embankment of the railroad, would make a dike which the water of the Chagres could not pass over. At the place where the line of the canal will necessarily cross the bed of the Chagres to fall into the Bay of Limon, the Chagres will be turned from its course to allow the canal to pass at its left.

On the other bank the river Trinidad, a left tributary of the Chagres, would be, on the contrary, kept on the right side of the canal, and, by means of an easy change of its course, would flow in the actual bed of the Chagres to that very river to the north of Limon Bay, taking therefore, to become itself a river, the river of which it was only a tributary. What, then, would be the expense of this radical change? We have not at hand all the details necessary to calculate it; but, allowing an expense of fifty million francs for this work, we think it would amply be provided for.

But, should this plan not prove successful, there is another suggested by Messrs. Wyse and Reclus, which is also perfectly feasible, and the expense of which can be more closely calculated. This is, to build over Cruces an immense reservoir, capable of holding more than six hundred cubic metres of water—that is to say, more than the volume of water which could possibly be formed during several days of the greatest overflows of the Chagres, which, we are told, amount to occasionally, but for a very short time, twelve hundred cubic metres a second. This work would cost twenty-five million francs, but it would free us from all apprehension of the devastation occasioned by this river, which at times becomes a torrent, for the letting it off under the reservoir would be done gradually and without danger into a bed arranged beforehand, leaving the canal always on the left. For opening this bed, which would not at all be the same one as that of the Chagres, for straightening it at different places, and for doing the same for the river Trinidad, seventeen million francs should amply suffice.

Freed, therefore, from all fear, nothing more remains but to regulate, I can say even to a few centimetres, the height of the water in the ship-canal; and then comes in the second change that we suggest to the plan of Messrs. Wyse and Reclus, which is, merely to provide against the occasionally very rapid currents which would come from the great rise and fall of the tide on the Pacific, which sometimes amount to six metres. This can easily be managed by a tide-barrier

in such a way that the level of the water in the canal will be regulated by that of the Atlantic, which varies but very little.

With these two modifications that we have pointed out to the plan of Messrs. Wyse and Reclus, and in fixing at four kilometres the greatest length of the tunnel—which can probably be reduced in length when the work is actually in hand, and perhaps be entirely done away with by a deep cut—your first sub-committee, over-estimating perhaps the expense calculated, brings the sum total to somewhat less than eleven hundred million francs, including the interest on the capital embarked during the time of construction, and the working expenses capitalized at five per cent. I feel confident that this figure will not be exceeded, and I am even confident that it will not be reached. Indeed, it is well known that the building of the railroad from Colon (Aspinwall) to Panama did not cost much more than such a work would had it been done in Europe ; and here we shall have to aid us in putting up the great workshops of the canal, at short notice, a railroad already built, which is in excellent running order from one end to the other, and has a good harbor on either side.

I have said enough to show, I think—and here is the second point in the programme of my address—that, whatever may be the plan adopted, canal with locks or canal on a tide-level, it is from the Bay of Colon to the Gulf of Panama that it should go.

Comparison of the Tide-level Canal with the Lock-Canal.—Let us now compare the relative advantages of these two systems. In a technical point of view the preceding discussion would seem to make any further development superfluous. Moreover, have we not heard, in the first sittings of the committee, M. Cotard himself, an advocate, I believe, of the former system, declare without contradiction that, if the tide-level canal was possible and could be made to pay, it would be preferable to one with locks ? Have we not heard and applauded the report of M. Fontane, the General Secretary of the Suez Canal Company, in which he tells you, in behalf of the Committee on Statistics, of which he is a member, that a tide-level canal is the only one that can supply the demands of the navigation of the entire world ?

After having shown that the construction of a tide-level canal is possible, and under what conditions it is possible and assured, it would only remain to prove that it would pay. Here the fine report of M. Levasseur, in behalf of the Committee on Statistics, a report which you heartily applauded at the last meeting of the Congress, makes my task an easy one. The report declares and proves that, at the time when the canal should be opened, it can reasonably count upon a commerce of more than seven million tons. Very well, the Suez Canal, which cost almost five hundred million francs, with three million tons only, and subjected to demands which the Interoceanic Canal will not have to undergo, is proposing a diminution of its charges to only seven or eight francs for actual tonnage, a tariff which could easily be dou-

bled without depriving the canal of a ton of the merchandise which is passing through it to-day. Under these conditions the Suez Canal is a prosperous enterprise. Its stock, which was issued at 500 francs, is now quoted at 750 francs, and its bonds, payable at only 500 francs, are sold for 570 francs.

Suppose, then, for the Interoceanic Canal an original outlay of double this sum, more than double, if you please, and put opposite this figure a traffic reduced in the first years to four million tons, instead of seven, and a charge of fifteen francs, which will be a very slight tax on commerce.

Can it therefore not be admitted that this great enterprise is of a kind to attract large capital seeking an advantageous investment? But these large sums will not be the only ones on which we can count. Let us not pay our century the poor compliment of supposing that everything is done on a mere money-making basis. The Interoceanic Canal will bring in subscribers from those who, captivated by the grandeur of the work, will wish to help it with their mite, without thinking whether or not they will get anything back. These subscribers—who will come from America, from Asia, and from Europe—these subscribers will have for their name legion. Once already, and under less favorable circumstances, they have answered the appeal of him who built the Suez Canal; they will not be wanting for the Interoceanic Canal Company, which will have as its chief and responsible head Ferdinand de Lesseps.

PREMATURE BURIALS.

By G. ERIC MACKAY.

THE difference between death and a state of trance—or, as the Germans put it, *Todt* and *Scheintodt*—has never been quite clearly understood by the generality of mankind. Society, which sometimes does its best for the living, does not always do its best for the dead (or those who appear to be dead), and he would be a bold man who, without statistics, should assert that men, women, and children are never, by any chance, buried alive. Are the bodies of the poor always examined with care before burial? Are deaths properly verified in days of epidemic, that is to say in days of social panic?

I propose in this article to call attention to a few instances of premature burials on the Continent of Europe: instances which involve stories of trance, or *Scheintodt*—a trance, the semblance of death, holding its sway over the human body for hours and days, and not merely for minutes, as in the case of ordinary fainting-fits. In days when land is dear, and burial rights are less sacred than the rights of

builders and contractors, coffins have been opened with the pickaxe, in the act of converting cemeteries into streets and gardens. Here a grave has been discovered whose inmate has turned in its shroud; here a corpse clutching its hair in a strained and unnatural position: dead men and dead women lying in their graves as dead men never lie in a Christian land at the moment of burial. The presumption is, that these people have been legally murdered.

A few months ago a young and beautiful woman, on the eve of her marriage with the man she loved, was buried in the neighborhood of Lodi, in Piedmont, in accordance with the doctor's certificate. The doctor was of opinion that the girl had died from excitement—overjoy, it is said, at the prospect of being married, but the legal name for the catastrophe was disease of the heart, and with this verdict her place in society was declared vacant. When the first shovelful of earth was thrown down on the coffin, strange noises were heard proceeding therefrom, "as of evil spirits disputing over the body of the dead." The grave-diggers took to flight, and the mourners began praying; but the bridegroom, less superstitious than the others, insisted on the coffin being unnailed. This was done; but too late: the girl was found in an attitude of horror and pain impossible to describe; her eyes wide open, her teeth clinched, her hands clutching her hair. Life was extinct; but, when laid in her shroud the day before, her eyes were closed, her hands were folded on her breast as if in prayer.

The "Medical Academy" of Milan, in one of its weekly reports, published on Wednesday, March 22, 1848, quotes a case of trance which occurred to an ex-nun of the suppressed convent of St. Orsola, named Lucia Marini. The lady was taken ill, and, to all outward appearance, died: she was known to be subject to a peculiar kind of fit, which required peculiar treatment, and was staying at the time of the catastrophe in the house of a friend, who had been a nun. The *becchini* (grave-diggers, who in this case were the undertakers) insisted on burying the body before night; the surviving ex-nun remonstrated, urging that she must first try the effect of friction and mustard-plasters applied to feet and stomach. Fearing to lose their fee, the men of death waxed wroth in their contention, and, seizing the body by the shoulders, were about to drag it out of its bed, when the "dead lady," moaning and muttering inarticulate sounds, turned restlessly on her pillow. The friend of Lucia Marini broke out into prayers, interrupted by tears; the men let go their hold, and one of them (the elder of the two) crossed himself devoutly. The other, with a great oath, declared it was "spasms"; the dead, in his opinion, being liable to convulsive movements if not properly straightened. But humanity prevailed over ignorance, and cupidity gave way to medical skill. The lady was thoroughly revived by a medical practitioner of the neighborhood, and lived for many a long day to tell the story of her escape from the tomb.

Another case in point is that of Cardinal Espinosa, sometime President of Castile. Philip II., King of Spain, one day, in a moment of irritation, addressed him as follows: "Cardinal, take heed! You are speaking to the President of Castile." The Cardinal understood that he was dismissed from office (the King being his own president), and fell to the ground as if stunned. The pulse showed no signs of life; the parted lips emitted no breath—the King's wrath had slain his minister. It was decided that the unfortunate Cardinal should be cut open and embalmed. The surgeon arrived and commenced his operations, when lo! in the midst of the cutting the patient awoke, and, with screams of agony, attempted to struggle with his operator! But it was too late. The wounds were mortal, and the Cardinal expired before the comforts of religion could be administered to him.

In some instances the victims of trance have been known to rise out of their coffins. A case is recorded of a young lady in Leipsic, who, being reported dead during a nervous attack, was placed in her coffin in her parents' house, and there kept duly dressed for the grave, with the lid of the coffin still unnailed. While the family were at supper she appeared in her winding-sheet at the parlor-door, pale and frightened, but fair to see, as before her supposed death. Father and mother and sisters started up with cries of horror, and rushed out of the room by another door, believing her to be a ghost. It was only after a long interval, during which they entered and found her at table, eating and drinking, that they persuaded themselves that the girl still lived. They found her coffin empty; *ergo*, the ghost in the parlor was a living soul! The doctor, the priest, and the undertaker saw the error of their ways, and the deed was canceled which declared the lady a corpse. On the following year another deed was made out for the same lady, and the same priest officiated, but not the doctor or the undertaker. The lady was married, and lived to be the mother of many children.

But let us go back a century or two in these inquiries. We come upon the story of the Abbé Prévôt, author of "Manon Lescaut," and, earlier still, upon that of Petrarch.

Prévôt was found in a forest, one fine summer's day, in a state of complete unconsciousness. The village doctor, who examined the body, declared that life was extinct, and commenced what he was pleased to term his *post-mortem* examination. But at the first thrust of the knife the unlucky author awoke, and, with a piercing shriek, gave up the ghost. Bruchier, the biographer of Prévôt, deplores this event as a serious loss to literature. "Manon Lescaut," which Jules Janin complacently calls the "Paul and Virginia" of vice, might, he opines, have had a successor, if not a rival, from the same pen.

Petrarch, when a middle-aged man, lay in Ferrara twenty hours in a state of trance, and was to be buried on the completion of the time laid down by law, that is to say in four hours, when a sudden change

of temperature caused him to start up in his bed. He complained of the draught and reprimanded his attendants. They had allowed a current of cold air to fall on his couch! Perhaps if the door had been kept shut, the poet, showing no signs of animation, would have been buried that day. Petrarch would have been defrauded of a large portion of his life, and the world would have lost, in consequence, some of its finest sonnets.

Misson, in his "Medical Anecdotes," tells a story of a lady who, in 1577, was buried alive in Cologne. This lady was the wife of a consul, and was placed in the family vault in gay attire, with rings on her fingers and a golden chain round her neck, as on her wedding-day. Robbers repaired to her grave at dead of night to steal her jewelry, and were taking the rings from her fingers, which were damp and swollen, when the lady awoke, and, sitting bolt upright, as if galvanized, stared and smiled at her visitors. One of the three men fell down in a fit, fearing the devil or his agency, and the others took to their heels "as if pursued by fiends." The lady walked home, and was received by her husband, first with fear, and afterward with transports of joy, and lived for many a long day in health and happiness. In the Church of the Holy Apostles at Cologne is a picture of the Consul's wife waking from the tomb, but the event is ascribed to a miracle, and death, and not a trance, is the subject of the picture.

But the resuscitated victims of apparent death do not always return safe and sound—hale in body and in mind—from the land of shadows. A carbineer in the Pope's service, named Luigi Vittori, was, not long ago, conveyed to the Roman hospital, and there, after a few days' acute suffering, registered as dead, his disease being "asthma." A doctor, glancing at the body, fancied he detected signs of life in it. A lighted taper was applied to the nose of the carbineer—a mirror was applied to his mouth; but all without success. The body was pinched and beaten, the taper was again applied, and so often and so obstinately that the nose was burned, and the patient, quivering in all his frame, drew short, spasmodic breaths—sure proofs, even to a non-professional witness, that the soldier was not altogether dead. The doctor applied other remedies, and in a short time the corpse was declared to be a living man. Luigi Vittori left the hospital to resume his duties as carbineer, but his nose—a scarred and crimson beacon on his face—told till he died (which was soon afterward) the sad story of his cure in the very jaws of the grave.

Stories are told of men who, after sentence of death at the hands of the doctors, returned to life blighted in intellect. Some of these victims of medical incapacity were men of position in society, but others—the great majority—were poor and friendless. Hospital cases have principally to do with the poor, and, in hospitals in warm countries, patients who show signs of approaching dissolution are quickly disposed of. Camillo de Lellis, the founder of an order of hospital monks, or

Brothers of Charity, speaks in his memoirs of the frequency of premature burials in Italy. "Ah, merciful God!" he exclaims piously, "how many living men and women are annually taken to their graves in this Christian country!" Camillo was of opinion that the victims might be numbered by many scores—nay, by hundreds—in the course of a single year.

One day, after visiting the beds of the sick in a certain hospital in Lombardy, of which the name has been left in blank, Camillo entered the *morgue*, and found strewed upon the floor a great number of corpses, one of which was bleeding profusely from the head. "A dead man can not bleed in this way," thought Camillo, and had the body taken to another room, and there examined. The man was alive, and but for an accident would have received burial. He had been thrown to the ground with some violence a short time previously, and, then and there receiving the wound above alluded to, recovered consciousness. But he only survived his sentence of death three days; he died of the blow which had awakened him from his trance.

But there are double deaths—twofold burials—which are perhaps the most horrible of all. Society thinks it is burying one person, but the "deceased," being a woman, may from the point of view of maternity include two lives, or even more. Gasparo Rejes tells the story of a child born in the tomb whose mother was buried alive. The lady was the wife of a man of property named Francesco Orvallos, and "died," while far advanced in pregnancy, during her husband's absence. Orvallos, returning home the day after the funeral, had the tomb opened, not because he suspected foul play, but because he wished to gaze once more on the face of his beloved. The lady was in truth dead, but death had transpired in the grave. A child, struggling into existence, met the gaze of the bereaved husband, and was removed without difficulty by a medical assistant. The mother was once more consigned to the dust, but the child lived to be a man, and, carrying till his death the name of "Fruit of the Earth," occupied for several years the post of lieutenant-general on the frontiers of Cherez. This story is reproduced by the late Professor Comi in his treatise on "Apneology." Those who doubt it have only to read the following account of what is called "Involuntary Homicide," which happened in the south of Italy (at Castel del Giudice) in November last, and of which accounts were published at the time in the Neapolitan and English papers:

A poor woman at Castel del Giudice, in the province of Molise, was taken ill with the premonitory symptoms of childbirth, and, having fainted away while the doctor was being sent for, was, on his arrival, declared dead. Burial follows death very rapidly in southern countries, especially in Italy: it is the night of the tomb setting in without the twilight of the death-chamber; and eight-and-forty hours in the north of Italy, and four-and-twenty in the south, is the time allowed

by law. If the "dead" awake in that time it is well. If not, they are doomed, and no one—not even a father or a mother, a husband or a wife—can save them from the hands of the grave-digger. This was the case with the poor woman of Molise. Her friends had doubts as to one, at least, of the deaths—that of the unborn babe—but the doctor was inexorable. He refused to operate on the "corpse" to save the infant-life, and the syndic, approving of his conduct, ordered the body to be buried. The funeral took place *exactly at the twenty-fourth hour*—that is to say that the body (being a poor one) was thrown into the ground like a dog. Dog-like, too, it had no rights, for a few days afterward it was unearthed to make room for another corpse—that of a girl—which was to be thrown in over it. But the *becchini* (the grave-diggers) perceived while doing their work that the woman buried the week before "had moved in the grave." Her hands were up to her mouth; her eyes were wide open and staring frightfully—she had been trying to bite the bands by which her wrists were fastened. But the bands of her legs were rent asunder, and there, in the dust beside her, was a dead child! The woman and the babe (a boy) whom law and medical incapacity had slain were taken out of the earth to be medically examined and legally provided for, and the new corpse (was it a corpse?) was thrown in in their stead. The doctor and the syndic were arrested, and condemned to three months' imprisonment, and the mother and child were buried again with two medical certificates instead of one. The legal authorities—somewhat late in the day—wished to do everything in "proper form," and the child, born in the grave, procured for its mother a second burial.

This horrible crime—the crime of burying a woman alive and murdering an unborn babe five or six feet underground by medical sanction—could with difficulty have occurred in England. English law provides an interval of a week (more or less) between death and burial, and the seeming-dead may in a week's time return to life—that is to say, that the body, with the suspended life dormant within it, may, by chance or by medical treatment, reassume its functions, or a portion of its functions, before burial has become a legal or a sanitary necessity; but it can not be stated with certainty that all persons buried in a northern climate—such a climate, for instance, as England—are in reality dead after the delay of a week has been accorded. Hasty and sudden burials are not always a question of climate or of temperature. In times of pestilence the week's delay is in many cases, even in northern climates, reduced to a few hours; and in Italy, where the minimum interval between death and burial is a day and a night, and the maximum two days and two nights, the victims (or the supposed victims) of epidemic are buried as soon as dead—that is to say, as soon as they appear to be dead, which, in exceptional times, amounts much to the same thing. The manifest blunder is that of supposing all dead persons—i. e., all persons dying in days of pestilence—to be

dead of that particular pestilence; and the excuse for it, if excuse it be, is the desire to remove from the living all possibility of contagion from the bodies of the dead, dispensing with experiments with a view to reducing risk; and making sure, so to speak, of the corpse without giving it the benefit of a doubt.

The fact is, that the modern inhabitants of Italy—i. e., modern Italian legislators—are extremely intolerant of what may be called the romance of the death-chamber. Reverence for the deceased, a craving for the companionship of the unburied corpse, is not encouraged in Italy. As soon as life is extinct, or is believed to be extinct, the human being ceases to be sacred. It is earth or clay and nothing more, and the glamour of a beloved face which no longer smiles does not, to an Italian mind, speak of a soul hovering near the body, a soul asleep, not dead, which haunts the chamber of woe, and makes itself felt, as it were instinctively, in the presence of the mourners. Theology teaches Italians that the soul of the deceased is in purgatory, and that the altar and not the death-bed is the place to kneel at; so that, by kneeling and praying and doing penance(by fees and masses), mourners may be able to comfort the souls of the departed in the limbo they inhabit. Corpses belong in the first instance to the priests (who, after the unction by sacred oil, light tapers by the bedside); and in the second instance to the legal or sanitary authorities who employ the grave-diggers. The death-chamber is abandoned by the mourners, who flock to the church; and the room, and sometimes the whole house, is furbished up, and even whitewashed, as if the death of a near and dear relative had brought contamination upon it.

Now, it would be interesting to discover at what period of history the Italians began to be so severe in their treatment of the dead. The ancient inhabitants of Italy were by no means so rigorous. They were tender in the death-chamber, and careful at the funeral-pyre; though pagans, they were merciful in matters of life and death. Their burial laws were to a great extent similar to those of England—similar as regards the interval between death and funeral, and only different as regards the funeral itself.

The Romans had indeed many experiences of official and medical blundering, and that is perhaps the reason why they were, at certain periods, so careful in their funeral rites. Pliny tells the story of the Consul Acilius, who, being reputed dead, was placed on the pyre, and started up to shriek for assistance while the flames were gathering round him; but too late to be saved. Lucius was burned alive; and Tuberus, waking from the trance of death while preparations were being made to burn him, was removed by his friends and others from the stake. The interval between death and funeral was fixed at eight days. It was seldom less, and it was sometimes more; for Licurgus, in his anxiety to prevent accidents—i. e., medical and judicial murders—fixed the interval at eleven days. Why do the modern Romans,

and all the modern inhabitants of Italy, insist on burying their dead within forty-eight hours? Simply—say the legislators—because the climate requires it; i. e., because it would not be fair to the living to allow the dead to remain unburied for a longer space than two days and two nights. Query: was the climate of Italy under Julius Cæsar very different, in point of heat or moisture, from the climate of Italy under King Humbert?

But it has always, and in all countries, been difficult to ascertain the difference between *Todt* and *Scheintodt*—death and the semblance of death. Dr. Gandolfi, a learned Italian writer, whose work on "Forensic Medicine" * was revised by the illustrious Mittermayer, is of opinion that medical men are themselves liable to make mistakes on this important question. He says—1. That "the organic phenomena which precede apparent death can not of themselves be distinguished from those which precede real death, and that for a certain time it will be difficult to decide, scientifically, whether life be suspended, or extinct"; and, 2. That "many phenomena which announce real death are the common and necessary indications of apparent death, as for instance the want of motion, of sense, of breathing, and of pulsation."

These are terrible sentences! How many persons are denounced as dead simply because they have ceased to breathe and move and show signs of a pulse—persons who, according to Gandolfi, may not, in all cases, be ready for burial! It is Gandolfi's opinion that persons "denounced as dead" may in some rare instances be the witnesses—the mute and fear-stricken witnesses—of their own funeral; that they may know perfectly well that they are going to be put into coffins, and thence into the earth, and yet be powerless, alive as they are, to avert the catastrophe of a legal murder! The following illustration of this point is authenticated by Bruhier, and is quoted, in slightly different words, by Dr. Gandolfi:

A schoolmaster in Mohlstadt, named Wenzel, was legally denounced as dead, and got ready for burial. He was to be buried on a certain fixed day, but his sister, who lived far off, had not arrived; and it was decided that the funeral should be postponed. The "deceased," in his winding-sheet, unable to move, and apparently unable to breathe, heard with joy of this delay, and tried, but utterly in vain, to open his eyes, which were fast closed. His sister arrived, and, finding him dead, burst into a paroxysm of tears, and, seizing his hand, reproved him passionately for thus dying without one word of farewell. She took his head between her hands, and, pressing it wildly, looked at him with a fixed and half-demented scrutiny. The eyelids of the "deceased" were seen to quiver; the eyes half opened; he was saved! He had succeeded in putting his latent self in communication with the outer world; and what he himself had begun the doctors completed. Here was a man who, but for his sister's delay, would have been buried

* "Medicina Forensa Analitica," by Giovanni Gandolfi, Milan, 1868.

alive! Bruhier's story is, in fact, the confession of Wenzel. It is the story of a patient describing his horror on finding himself a dead man; and, without much confusion of terms, it might fairly be called the "Confessions of a Corpse." Dr. Gandolfi asserts that many such cases have been recorded in various parts of Europe, and that in most instances the cases have been "proved and authenticated." Gandolfi is an authority; and all persons of a quibbling or skeptical nature would do well to consider the matter thoroughly before condemning his evidence.

But it is needless to prolong the list of examples. Enough has been said to show the wickedness of hasty funerals, and the necessity of establishing a proper system of tests. But these tests, so long expected, are not forthcoming. Many physicians are, indeed, of opinion that no such system is obtainable in the present state of medical science. There are, they affirm, a great many ways of proving death, if sufficient time allowed be for experiments; but during the experiments, or before the experiments have begun, the supposed corpse may, they declare, pass from apparent to real death, and thus, without sign or warning, frustrate all inquiry. Celebrated physicians can not be at the death-beds of all sick persons. The poor, and even the rich, must oftentimes content themselves with the services of doctors who are not famous either for learning or intuition; and the medicines and appliances by which distinguished physicians might succeed in testing the existence of life, in persons suffering from trance, would, in the case of poor people, cost too much; and no one is willing to guarantee their final success. For it is important to bear this point in mind: it is one thing to certify that a "corpse" is not really dead; it is another thing to revive that corpse after the inner life—latent and slow to assert itself—has been properly recognized. No; what is wanted is a *simple* test, and not a complicated test, or a complicated series of tests, which would be out of the reach of the poor, and beyond the power of inexperienced or badly-paid doctors. Let us have that test as soon as possible! No doctor deems it an impossibility. It is a matter of difficulty, and that is all. But difficulties as great as, or greater than, this have been mastered over and over again by modern science. —*Belgravia.*

WHY DO SPRINGS AND WELLS OVERFLOW?

By JOSEPH J. SKINNER, Ph. D.

THE commonly accepted answer to the above question is that the water of springs and of flowing wells is forced out by the pressure of other water at some higher level, this pressure being transmitted to the water of the spring or well through continuous underground

channels, either containing water alone or water filling the interstices of some porous material, these waters being the product of rainfall, dew, and snow. But this answer has sometimes been found not to satisfy a certain class of minds; and, as long ago as 1834, Arago thought it not beneath him to publish in the "Annuaire du Bureau des Longitudes" for 1835 a considerable essay, in which he shows conclusively that the rise and flow of water in springs and artesian wells are sufficiently explained by the cause assigned above. Further on will be found a translation of some passages from this elegant essay.

Arago was so certain of the correctness of his views, that from his knowledge of the geological formations of France he not only foretold that potable water would be found by boring an artesian well at Grenelle, near Paris, but that the water would rise and overflow the surface. In 1833 he succeeded in getting the French Government to undertake the boring of this well, and although about eight years were required to complete it and it was for some time in danger of being abandoned, his urgent representations prevailed in obtaining a further prosecution of the work, and in 1841 his foresight was rewarded with the splendid success familiar to the public. Modern engineers, in judging of the chances of getting flowing water from an artesian well in any particular locality are guided by the same general theory as that held by Arago.

But a writer in the November number of this magazine combats this theory, "not merely from speculative motives, but in the interest of public health," and offers an explanation of his own, involving a "newly discovered force" which "not only may, but which positively must, force waters out of springs at high elevations." This "new force" as it is called in another sentence, is "the resultant of the earth's centripetal and centrifugal forces," and it produces springs and flowing wells by acting "impulsively upon the subterranean water deposits," tending "to force them into and though the natural channels of the earth's crust." It is proposed here to examine Mr. Green's article in some detail, in connection with a consideration of the generally accepted theory of springs and flowing walls.

A peculiarity in one or two of Mr. Green's quotations led me to verify them in the works cited by him, and in doing so I could but notice that he had apparently made a number of slips of the pen, which, though perhaps unimportant in themselves, yet give indication of some carelessness. For instance, in quoting from "Littell's Living Age," he changes *Colne* to Coln, *Watford* to Wetford, *Pole's Hole* to Pales's Hole, *Dickenson* to Dickinson, *Canstadt* to Constadt, *Bruckman* (which should have been *Bruckmann*) to Buckmann, and *predicted* to discovered. Another of his quotations from the same source is this, "The artesian well at Tours rose with a jet that sustained a cannon." The original said, "An artesian well at Tours rose with a jet that sustained in the air a cannon-ball." As the account of

Professor Buckland's address given in "Littell's Living Age" was not a *verbatim* report, even this statement seemed to me likely enough to have suffered a slight change at the hands of the reporter; so I went one step further back, to Professor Buckland's "Bridgewater Treatise," of which he spoke in his address, where I find this statement: "At Perpignan and Tours, M. Arago states that the water rushes up with so much force, that a cannon-ball placed in the pipe of an artesian well is violently ejected by the ascending stream." Something like this is probably what Professor Buckland said in his address; and the difference between the ejecting of a ball from a pipe and the sustaining of it in the air may have seemed to the reporter of the address of slight consequence; but when you go from *ejecting a ball from a pipe* to the *sustaining of it in the air*, and then to the *sustaining of a cannon*, one is reminded of the man who was said to have thrown up something as *black as a crow*, and as the story passed from mouth to mouth he was finally declared to have thrown up *three black crows*.

On page 76 of the November "Popular Science Monthly," in discussing Mr. Howell's article on the "Subterranean Outlet" to the Upper Lake region, Mr. Green says of Mr. Howell that "having shown that Lake Superior at its surface is 600 feet above the Atlantic and at its bottom 573, and Ontario to be 235 feet above, with the same depth as Superior, he proceeds to make the following significant statement." This quotation would make Lakes Superior and Ontario each only twenty-seven feet deep, which is evidently a mistake; and on referring to Mr. Howell's article in "Scribner's Monthly" we find that he did not say that the bottom of Lake Superior is 573 above the Atlantic, but that "we find its bed descending 573 feet *below* the level of the Atlantic"; neither did he say that Ontario has the same depth as Superior, but that it "descends to an equal distance below the level of the Atlantic."

But let us begin at the beginning of Mr. Green's article, and see how he starts off. After a few words of introduction, he quotes from the account of Professor Buckland's address a few sentences ending as follows: "At Brentford, England, there were many wells that continually overflowed their orifice, which is a few feet only above the Thames. In the London wells the water rises to a less level than in those at Brentford." Mr. Green then says: "By hydrostatic pressure, the Professor, of course, means a head, i. e., that the water flowed to these wells from a higher point. If this rise were due to hydrostatic pressure, why did the water rise to a lower level at London than at Brentford among the hills?" Now, Professor Buckland's statement, just quoted, makes the orifice of the Brentford wells "a few feet only above the Thames," and Mr. Green makes his first imaginary difficulty by placing these wells "among the hills." He then quotes largely from Professor Buckland's address, and afterward exclaims: "Wells to supply London, the Professor thinks, must not be utilized

to draw water from a depth of thirty or forty feet, because it would cut off the supply due to the rains which do not sink deeper than three feet!" But the Professor had not said that "rains do not sink deeper than three feet." He had, indeed, said that one intelligent manufacturer, Mr. Dickenson, had found by a rain-gauge that "except in *December*, *January*, and *February*, rain-water rarely descends more than three feet below the soil," etc. This statement apparently convinces Mr. Green that rain-waters *never* get deeper into the earth than three feet. But there are soils and soils.* And Professor Buckland did not neglect to point out their differences. He said, "The rain that falls on the uncovered *chalk* within the area of these basins (like that of London) descends, by countless crevices, into the *lower regions of the chalk strata*," etc. And even Mr. Dickenson's observations *during many years* had shown him that, in spite of the fact that in the drier part of the year the rain-waters rarely sank into his *soil* more than three feet, yet the quantity of summer water in the river Colne varied with the rain in the preceding winter. He probably knew, therefore, that these winter rains must be largely absorbed by the sponge-like chalk formations in the neighborhood, and slowly work their way downward many feet, to issue gradually at lower points in the form of springs to feed the river in summer.

Mr. Green quotes further from Professor Buckland's address, showing the great value of artesian wells in Wurtemberg, and then goes on: "From which quotations it appears that the Professor is in a remarkable position. At Wetford" (*sic*) "these wells could not be utilized because the river-supply of the Coln" (*sic*) "would be exhausted; but in Germany they were a new and important source of supply to the rivers themselves." The Professor's position may be remarkable, but it is certainly reasonable. For it is a well-known fact that in some localities, that of Tours for one, as stated by Arago, artesian wells may be bored to any number hitherto tried without sensibly affecting the flow of those first sunk in the immediate neighborhood, while in other localities every new well either diminishes the flow of old wells or makes the level of the water in them sink. This last is the case near London. The "American Cyclopædia," article "Artesian Wells," says: "In the vicinity of London it is observed that the height to which the water rises diminishes as the number of wells is increased. In 1838 the supply of water from them was estimated at six million gallons daily, and in 1851 at nearly double the amount, and the average annual fall of the height of the water is about two feet." Professor Buckland had also stated that "Mr. Clutterbuck demonstrated, by a long-continued series of measurements of the water in the chalk-hills of Hertfordshire, near Watford, that every drop of water taken from that neighborhood would have been ab-

* Arago said—but he apparently lived too early—"Every one knows that in many places the upper ground is of sand, and that sand lets water through it like a sieve.

stracted from the summer and autumn supplies of the river Colne." Hence, even if the wells in Germany were, as stated rather strongly by Mr. Green, "a new and important source of supply to the rivers themselves," it would not alter the fact, shown by experiment, that the proprietors of mills on the river Colne, and the owners of adjacent water-meadows, would have been robbed of rights which they had inherited from time immemorial, by drawing the water-supply of the great city of London from wells in the chalk formations of Hertfordshire.

But Mr. Green's two propositions that differ most essentially from the commonly accepted theory of artesian wells are—1. That the flow of water from them is not due to pressure transmitted from water at a higher level, but to "some force not yet identified"; and, 2. That the supply of water for such wells, and indeed for ordinary springs, comes from "subterranean waters, seldom if ever influenced by rains" (p. 75, line one). Mr. Green identifies the required force as "the resultant of the earth's centripetal and centrifugal forces," and, having found that the tendency of this resultant is to force water *up*, wherever there is an opening upward in the earth's crust, of course it is necessary to suppose that there is a plenty of subterranean water already down. He seems to think it entirely unnecessary to suggest any means of replenishing the supply of this subterranean water, or even to imagine that it could ever need replenishing.

Listen to Mr. Green: "Imagine the 'majestic column' at Grenelle rising thirty feet high, and the overflow in the other cases being due to hydrostatic pressure—i. e., due to the fact that all these immense floods were the result of a flow from some other higher bodies of water." Ordinary people will find it as easy to imagine this as to suppose that these floods are the result of flow from *lower* bodies of water unconnected with higher ones. But he goes on: "Why did it not occur to Professor Buckland that, however high and abundant the source, such drains must of necessity have sooner or later exhausted the supply, if no equivalent streams were flowing into that also? But suppose this" (*sic*) "to be so, whence could come the higher head to flow into and supply that in turn? Carry this on until a flow is secured from the highest land on the earth, and then whence comes the flow to supply that?" This is beautiful. Why did it not occur to Mr. Green that, however *low* and abundant the source, such drains must of necessity have sooner or later exhausted the supply if no equivalent streams were flowing into that also? But suppose this to be so, whence could come the *lower* head to flow into and supply that in turn? Carry this on until a flow is secured from the *center of the earth*, and then where are you?

In another place (p. 81) Mr. Green says: "Suppose it had been *fully proved* that a particular overflowing spring was caused by hydrostatic pressure, it would still remain to be accounted for how the water

got to that higher point. This can best be done by the force demonstrated," etc. But supposing, if you can suppose, that a particular overflowing spring were caused by Mr. Green's "newly discovered force" acting on a lower body of water, it would still be for him to show how, according to his theory, the water got to that lower point. His position plainly is (see p. 81), that if any openings exist between bodies of water imprisoned in the earth's crust and the surface of the earth, these waters, unless entirely isolated bodies, would as a rule flow upward. If there were millions of cubic miles of water in accessible subterranean reservoirs, and no drain on them but that caused by the wells made by man, the supply might be considered "ample for all practical purposes," no matter how it got there or what forced the water up; but Mr. Green argues that not only flowing springs but the bulk of the waters of the rivers St. Lawrence, "Ganges, Nile, Indus, Senegal, Rhine, Rhône, Vistula, Elbe, Loire, Gaudiana, Po, Adige, Swale, Tay, Severn, Don, Monongahela, Platte, Missouri, and numerous others" must be derived from a subterranean water-supply, which, he says (p. 77), "is known to be constant, and has always been so." One would think that rivers like those mentioned, flowing for centuries, if fed by a *subterranean water-supply*, would ultimately make a serious drain on the subterranean reservoirs; but, although Mr. Green's theory does not admit the possibility of any water getting back into these reservoirs, rivers and wells still flow.

After giving Professor Buckland's illustration of the theory of artesian wells, in which he likens the case in nature to a layer of sand and water between two saucers, Mr. Green says, "Should these exceptional and assumed conditions occur in nature, the result would be substantially as indicated." But we know that similar conditions do occur, and not very rarely either. He continues, "But, as will be seen at a glance, the flow from a well sunk under such circumstances would be limited to the amount of water between the two saucers, and this will be limited to the quantity of rainfall." This is very true. He adds, "Since flowing wells and springs are seldom if ever thus limited, we infer that the case supposed does not occur." On the contrary, we have every reason to believe that flowing wells and springs are almost always thus limited. Mr. Dickenson's observations, already quoted by Mr. Green, proved that the quantity of summer water in the river Colne varied with the rain in the preceding winter. In every particularly dry summer springs by the thousand are entirely dried up, and the flow from the majority of others is greatly diminished. On the other hand, in wet seasons all but the most extraordinary springs have their flow increased. In some geological formations increase of flow occurs very soon after the beginning of rains. Arago states as the uniform observation of miners, especially those of Cornwall, that in mines situated in the midst of certain limestones water increases in the deepest drifts a *very few hours* after it has begun to rain on the surface of the

earth. He also refers to springs on the coast which gush out from vertical cliffs of chalky limestone, which in the same way increase largely in strength immediately after rain.

That artesian wells are not sensibly affected by particular rain-storms is no proof that they are not ultimately supplied by rains, but only shows that the quantity of water furnished by the wells is exceedingly small compared with the total quantity at any time in the layer of porous material tapped by the wells. Such layers, between two saucer-like formations of impermeable matter, would generally have some points of their outcrop at a lower level than others. At these low points of the outcrop natural springs would occur, which would have a flow more or less constant in proportion to the extent and height of the porous layer above them, and their flowing would continually tend to draw the level of the water in the porous layer down to their own altitude. Rains, falling on the exposed edges of the porous layer, would in great part be absorbed, and, gradually trickling through the pores, be slowly discharged by these natural springs. If an artesian well had its opening into the porous layer far below the lowest of these natural outlets, no ordinary rain would sensibly change the effective head of water that supplied it; but, if rains should cease entirely, the springs and the well would ultimately stop flowing. In a work on "Water-Supply Engineering," which contains much valuable information, Mr. J. T. Fanning says of such a geological formation as the common theory of artesian wells assumes, that when first discovered it "is invariably full to its lip or point of overflow. Its extent may be comparatively large, and its watershed comparatively small, yet it will be full, and many centuries may have elapsed since it was molded and first began to store the precious showers of heaven. A few drops accumulated from each of the thousand showers of each decade may have filled it to its brim many generations since; yet this is no evidence that it is inexhaustible. If the perennial draught exceeds the amount the storms give to its replenishment, it will surely cease, in time, to yield the surplus." (Compare with this the extract given above from "The American Cyclopædia," showing an annual sinking of two feet in the level of the water in the artesian wells near London.)

Mr. Green can not account for the flow of streams from the mountain-region of Pennsylvania and from Lake Chautauqua without the intervention of his "newly discovered force." He quotes approvingly a statement that "it is a wonder to the unpracticed observer where the water-supply of Chautauqua Lake comes from." "Unpracticed observer," indeed! But the practiced observer will tell you without hesitation that the water-supply comes from the clouds. Mr. Fanning (*op. cit.*) states, as the estimate from experiments, that "in the Eastern and Middle United States the evaporation from storage reservoirs, having an average depth of at least ten feet, will rarely exceed sixty

per cent. of the rainfall upon their surface." It follows that any natural exposed basin, under these circumstances, would surely fill up, just from the rains on its surface, if there were not some outlet for the water. Mr. Fanning gives the mean annual rainfall at Fredonia, New York, a few miles from Lake Chautauqua, as 36·55 inches. If we assume that the lake has an area of forty square miles, and take the annual rainfall on its surface at three feet in depth, the total volume of this rainfall would be 3,345,408,000 cubic feet. Supposing that sixty per cent. of this is lost by evaporation, there will yet remain in average years 1,338,163,200 cubic feet of water to be somehow disposed of, which is more than would supply a stream eight feet wide and one foot deep, running for a year at the rate of three and a half miles per hour. Besides the rain falling directly on the surface of the lake, a calculation of the area of the land around it, at a higher elevation than its water-level, would undoubtedly show, no matter what unpracticed observers might anticipate, that the rain-water known to fall on this area would be ample to supply all the springs that flow into the lake, and leave a good margin of surplus to evaporate from plants and soil, and to filter away into the earth.

It seems as if Mr. Green must be somewhat imaginative when he says that, "from the highest mountains in the world—the Himalayas —*out of their highest points*, great cataracts and streams have poured and still do pour," etc. Has any man ever been anywhere near the highest points of the Himalayas to verify such a statement? I translate the following from Arago's work already mentioned:

"The argument chiefly depended upon by those who felt obliged to seek the origin of subterranean waters in the precipitation which intensely hot aqueous vapors, coming from central regions, had experienced at the moment of their contact with the cold, earthy layers near the surface, was drawn from a fact well worthy of examination: I mean the pretended existence of tolerably abundant springs *at the summit*, at the culminating point, of some mountains. Our little *Montmartre* itself figured in this polemic. There was, indeed, upon this hillock, a spring (perhaps it still exists) which was hardly sixteen metres (fifty feet) below its highest part. No water, it was said, could constantly feed a spring thus placed, without coming from beneath in the state of vapor. Upon examination, however, it was found that the portion of Montmartre above the spring, and which could consequently transmit its waters by the method of simple interior draining, was about five hundred and eighty-five metres long and one hundred and ninety-five metres wide. Now, the mean volume of rain which falls in Paris upon such an extent of ground, between the 1st of January and the 31st of December, much exceeds the quantity of water which the little spring in question annually yielded.

"It was necessary, then, to seek for the difficulty at another point.

"This was believed to have been found in a locality not far from Dijon; but there as well, in spite of appearances, the rain-waters received on the portion of land overlooking the spring could amply suffice for its supply."

After referring to the former ignorance of people concerning the quantity of rain, of dew, and of snow, falling in different regions, Arago continues: "For example, people did not believe that the basin of the Seine . . . . received annually by rain a quantity of water equal to the tribute which the Seine bears to the sea in the same space of time. Perrault and Mariotte first studied the question *experimentally*, and they found, as is usual in such cases, that the vague conceptions of their predecessors were precisely the opposite of the truth. . . . The volume of water which passes yearly under the bridges of Paris is hardly the third of that which falls in rain into the basin of the Seine. Two thirds of that rain either return into the atmosphere by evaporation, or sustain vegetation and the life of animals, or drain into the sea by subterranean passages."

Without insisting further on the fact that the rain-waters, dews, and snows falling on higher grounds must be sufficient to account for all flowing springs and wells (except, possibly, such cases as the geysers), let us see how Mr. Green's subterranean water-deposits are to be driven to the surface of the earth by his "newly discovered force." Why, by making the earth's centrifugal force act in the direction of the *tangent* to the earth's surface, and then getting the resultant of this force and of gravity! Further, since the question of the relative intensities of these two forces "does not enter into the problem," you may assume that they are equal, and thus you will find that "the direction of the resultant itself is, say, 45° from the direction of the force of gravity. . . . Moreover, since the resultant has been shown" (by saying that the diagonal either of a square or of a *parallelogram* is longer than either of its sides) "to be greater under all circumstances than gravity, certainly the vast aggregations must also be greater than the aggregated gravity, and will be able to overcome it under the conditions stated. . . . The intensity of the centrifugal force will increase with the distance from the center of the earth, while gravity will decrease; the *resultant will also increase.* Thus we find the strongest and most abundant overflows at the tops of mountains or on high plateaus."

As a specimen of mechanical exposition this is almost unique,* but it is too ludicrous to mislead. In point of fact, as every schoolboy ought to know, the centrifugal force due to the earth's rotation, on a particle at any place on the earth, does not act in the direction of the tangent

* Mr. Green is not quite the first writer who, in undertaking to overthrow a well-established mechanical explanation of natural phenomena, has assumed that the earth's centrifugal force acts in the direction of the tangent to its surface. (See discussions on "The Tides," in vols. xi. and xii. of this magazine.)

to the earth's surface, but in the outward direction of the radius of the circle of latitude of the place; a diagonal of a *parallelogram* is frequently shorter than either of its sides; the centrifugal force acting on a particle, due to the rotation of the earth, is never more than about the $\frac{1}{289}$ part of the force of gravity; the direction of the resultant of this centrifugal force and of gravity is always very nearly that of gravity; the intensity of this resultant is always less than that of gravity; and instead of increasing with the distance from the center of the earth it decreases. Perhaps these are points that make no difference in the value of Mr. Green's theory; but still they are worth the consideration of any one who proposes by contraries to upset the doctrines of such men as Arago, Faraday, Garnier, and Halley.

Not even the wonderful fact mentioned by Mr. Green, that "by inclosing an overflowing spring tightly, and allowing the inclosure to be terminated by a tube with an opening carried to a level below the fountain, the flow was increased"—not even this will overthrow the principles of mechanics, as any one who ever understood a siphon would know. Mr. Green says, "the flow was increased because the channel was increased, and the resultant of the natural forces with it." But if the resultant increases with the distance from the center of the earth, then why could he not increase the flow still more by running the tube to a great height above the fountain instead of below it? But even Mr. Green would hardly expect to increase the flow by such means. For it is well known that by confining the water of an artesian well to a tube in which it must rise above the ground, the natural flow is rapidly diminished as the height of the tube increases. The "American Cyclopædia" says: "The flow from this well (at Passy, two miles from Grenelle) began slowly, but on September 27th (three days after striking the water) had reached over 5,500,000 gallons per day. The yield at the mouth was greatly decreased when raised through a tube twenty-five feet high; a like result followed at Grenelle, where the yield was 440 gallons per minute at the surface, but decreased to 135 gallons when forced through a tube thirty-three feet high." Mr. Green will have to charge this great decrease of flow to something besides increase of *friction;* for it is easy to see that, if the tube were extended up just to the point to which the water would rise without flowing out, there would then be *no* friction. In fact, the laws of hydraulics and hydrostatics have something to do with the subject of artesian wells.

I have already mentioned some inaccuracies of statement in Mr. Green's discussion of Mr. Howell's article in "Scribner's Magazine." Mr. Green, finding that the difference of level between the surfaces of the water in Lakes Superior and Ontario is three hundred and sixty-five feet, becomes certain that there can be no subterranean water-connection between these lakes; for, he says, "If this channel exists as supposed, the surfaces of these lakes would find a common level,

instead of a difference of three hundred and sixty-five feet"! Here is where Mr. Green should have brought in his ideas on friction, and have studied Professor Buckland's address more closely. In that address it is stated that "the surface-line of any subterranean sheet of water may be ascertained by measuring a series of wells at distant intervals along the dip of the stratum under examination. . . . Mr. Clutterbuck had further observed that the surface-line of subterranean sheets of water was not horizontal, like the surface of a lake, but inclined at a rate varying from fourteen to twenty feet per mile, in consequence of friction caused by the particles of the strata through which those sheets of rain-water descended with retarded motion to be discharged by springs. This inclination of the subterranean water-line in the chalk of Hertfordshire had been found, by Mr. Clutterbuck, to be nearly at the rate of twenty feet per mile in the chalk between Sir John Sebright's park at Beechwood and the town of Watford; and fourteen feet per mile in the chalk under tertiary strata in some parts of the basin of London. The engineers of the Southampton Railway had found a similar fall of about sixteen or seventeen feet per mile in the wells at the railway-stations between Basingstoke and Southampton." Without expressing an opinion of my own as to whether there really is or is not a subterranean water-channel between Lakes Superior and Ontario, it is evident enough that, even if there is, its size and character, as being more or less obstructed by solid or porous materials, together with its length, would have *some* influence in determining the quantity of water which could flow through it, even with a difference of water-level over its extremities equal to three hundred and sixty-five feet. Unless, therefore, Mr. Green's "newly discovered force" should suddenly cease to make Lake Superior an "overflowing spring of subterranean water," or, rather, unless the region from which Lake Superior gets its water should be deprived of its yearly rains, we need not immediately look for a common level of the water in Lakes Superior and Ontario.

CORRESPONDENCE.

"WASTED FORCES."

Messrs. Editors.

A RECENT issue of your "Monthly" contained a criticism, by Mr. J. W. Cloud, of some points in my paper on "Wasted Forces" published in yours of July, in which it is alleged I am in error. I had intended replying at once to this criticism, but have been prevented until now by circumstances. My critic makes the point that, in my attempt to account for the low duty of the steam-engine, I have ignored one of the chief elements of the problem, namely, "the low efficiency of the medium."

To this criticism I beg to reply that for the purpose of showing the margin for possible improvement in engines, whether deriving their motive power from steam or any other medium, the only elements entering into the problem are those I have named in my article, to wit: 1. The amount of work that should be given out, and which is the equivalent of the number of heat-units imparted to the medium by the combustion of the fuel; and, 2. The amount of work actually realized. The difference is the loss, and this loss is due *not* to "the low efficiency of the medium," but to the low efficiency of the machine.

To make myself quite plain, I will add my understanding of what a perfect engine should be. The perfect engine, hypothetically stated, is an apparatus that will utilize all the heat-units evolved by the complete combustion of fuel in the generator in the generation of steam; that will use all the steam that the generator supplies, converting it into water in so doing; that will put that water back again into the generator whence it came; and that will give out during a given time an amount of work that shall be the equivalent of the number of heat-units that have disappeared during that time.

I confess my inability to perceive what the question of latent or sensible heat has to do with the problem; and, in view of the fact that my critic has taken the pains to warn the readers of the "Monthly" that my statements might give false impressions, I wish to reaffirm the strict correctness of the theoretical view I have advanced; and to assert, my critic to the contrary notwithstanding, that the difficulties in the way of increasing the duty of the steam-engine to a very close approximation to that which theory calls for are *purely of a mechanical nature, and therefore not beyond the power of mechanical science to overcome.*

This is the gist of the matter, and I take direct issue with my critic in denying that the element of the high latent as compared with the low sensible heat of the medium, whether it be steam or any other, that is used, is the impassable barrier to future improvement that he would make it appear.

On another point that my critic makes, namely, that I throw too much of the responsibility of the low duty of the steam-engine on the generator, I have no hesitation, after further inquiry into the subject, to yield to him, and to admit that fifty per cent. would have been nearer the truth than twenty-five per cent., which I gave in my paper. I gave that figure simply as an opinion derived from a practice that is exceedingly variable and complex, and therefore liable to wide differences of result.

Very truly,

WILLIAM H. WAHL.

EDITOR'S TABLE.

RECEPTION OF THE "DATA OF ETHICS"

THE science of morals is as legitimate as the science of rocks, and far more important. When, therefore, a new step has been taken in its development and exposition, we are interested in all the indications of its recognition. The reception of Spencer's "Data of Ethics" shows on the whole a very marked progress of religious liberality. There is much protest but large concession, while the expressions of intelligent appreciation and cordial sympathy are many and emphatic. We give some illustrations, with comments, of the manner in which his position is now regarded.

We certainly never expected to live

long enough to see the name of Herbert Spencer received with applause in a great religious convention of orthodox people; but, if the report of the London "Times" can be trusted, this extraordinary phenomenon has actually occurred. That paper of October 10th contains a report of the Church Congress held this year at Swansea, and presided over by the Bishop of St. Davids, in which the question of "Internal Church Unity" came up for discussion. The Reverend Professor Pritchard gave an eloquent and powerful address on the "Religious Benefits from Recent Science and Research," in which the doctrine of evolution was assumed as true, and as in entire harmony with all essential religious truth. He was followed by the Reverend Professor Watkins, of St. Augustine College, Canterbury, who spoke on the same subject. He said: "The currents of higher religious thought in England were being influenced by two main forces; one was the theory of evolution, the other comparative theology, or the so-called science of religion itself. The theory of evolution came to them with much of the charm of novelty, and commended itself as emphatically of British growth. It was probable, indeed, that this induction of inductions was but a step to higher inductions. Still he felt sure that, when the history of this century came to be written from the standpoint of the future, the name of Herbert Spencer would be found in the very first rank among English thinkers. [Cheers.] In ultimate principles he differed from Spencer *toto cælo*, but he was therefore the more anxious to acknowledge the greatness of his work, and the philosophical spirit in which it had been conducted. [Hear, hear!]"

It is a common remark that all transitions of belief are painful, and none know better than intelligent missionaries how painful are transitions of religious belief. It matters little that the change is from a lower to a higher faith; violence is done to long-cherished ideas, and there is a sense of bereavement whatever the superiority of the new creed. Those, therefore, who are in the habit of having their morality garnished with theology and are accustomed to mix these conceptions and their terminology, will naturally shrink from the attempt to separate the ethics and treat it merely as an independent system of scientific principles. Such devout people will naturally look upon the "Data of Ethics" as a cheerless book. They yearn for the blessed words that have become polarized by long and sacred association. The reviewer in "Harper's Monthly," after giving a very fair account of the work, closes by expressing this idea as follows: "The treatise is a model of condensed and lucid statement, and of subtile reasoning, but the reader will be struck by the inexpressible dreariness of its tone, as if its author had verified in his own experience the simile of one of our greatest living poets, that 'the setting of a great hope is like the setting of the sun—the brightness of our life is gone.'"

It is possible that the writer believed what he here says, but it is more probable, we must say, that he was merely writing with the delicate caution thought necessary under the circumstances. The penalty of a "hundred thousand circulation" is that writers must be solicitous to *reflect* public sentiment rather than to *lead* it, and the practical result is that they generally *follow* it afar off. Our whole nation is ahead of this sentimental craving to keep things mixed which ought to be separated. We have separated the Church from the state, with great distress to many, no doubt, but with the most wholesome consequences. We have secularized our public instruction, and, although there are still many who bemoan the inexpressible dreariness of our godless education, the good sense of the country has long since ceased to heed the

ecclesiastical lamentations over our policy. The disentangling of ethics from theology and the treatment of it as an independent science were demanded as a logical requirement of our educational system, for morals must be taught in public schools, while religion is left to the special agencies of spiritual instruction. And, if the country has thus decreed the divorce, why mourn over a book which merely conforms to it, and which furnishes the best defense of the national wisdom in making the divorce?

But the characterization of Spencer's work as dreary and the suggestion about "the setting of a great hope" are untruthful, and are probably morbid subjective illusions of the writer. The "Data of Ethics," so far from being a dreary book in its spirit and tone, is, on the contrary, a book more buoyant with hope and more full of rational encouragement than any former philosophical treatise upon morals ever written. It connects the moral duty and improvement of man with pleasure and happiness more closely and profoundly than any other ethical system hitherto promulgated. It arrays the grand results of modern science against a spurious metaphysics to stem the black tide of advancing pessimism; and it appeals to the unfolding of the universe as giving trust of something brighter and better for man—yet to be realized this side of his chances of perdition. Other reviewers of "The Data of Ethics" have not failed to recognize and to declare this quality of the book.

A writer in the "Home Journal" of November 16th closes an interesting account of Spencer's work as follows: "To whatever criticism the system of ethics which is thus logically developed from the law of evolution may be subjected on the part of the opponents of the evolution theory, yet this at least is evident—that as an instrument for the acceleration of the progress of society toward the beautiful ideal which it sketches out, as a stimulus to individual exertion in furtherance of this high aim, the new system is immeasurably superior to all antecedent theories of life. While other systems have encouraged the hope, none have supplied the data of a rational faith in the ultimate realization of a lofty morality among the masses of mankind. Nay, the prevalent codes which claim for themselves a supernatural origin make it their duty to proclaim the native impotency of man, and place the realization of their ideal quite beyond this 'vale of tears.'

"Believe in the perfectibility of men, believe that society in the very conditions of its existence is impregnated with the potency that insures this perfectibility, and a great step is made toward the end desired. Faith in this preëstablished destiny—the faith that the laws of the universe are working in and through and side by side with the aspirations and endeavors of individual men, can not fail but impart a new impulse to these aspirations and a new vigor to these endeavors."

Equally to the point are the words of a critic in "The Nonconformist" of November 5th—a journal which is the leading organ of English orthodox Dissenters. After an excellent analysis of the work, the writer remarks: "The value of the discussion in this volume is the glimpses it affords into the future which its author anticipates. No loftier view, we venture to think, was ever entertained. Whatever may be the opinions we hold respecting the origin of our ideas of right and wrong, and of the sanctions by which they are enforced, we can not refrain from admiring the optimism of Mr. Herbert Spencer. It is as pure and sublime as that of the most spiritual seers of the past, and it involves as radical a change in human nature as that demanded by the New Testament. It is, in his own words, 'a rationalized version of its ethical principles.' He feels, as we feel in reading

his works, that his conclusions will not meet with any considerable acceptance. The fact that they are Christian in their essence is rather a hindrance to their acceptance, since conventional Christianity practically repudiates the ideal morality of its founder."

The presidents of colleges have found themselves called upon to define their position in regard to the "Data of Ethics," and their outgivings, though somewhat discordant, are none the less instructive.

It is now nearly ten years since President Porter, of Yale, in a little book on "Man," said in relation to Herbert Spencer: "No well-read student of philosophy can hesitate to believe that, notwithstanding the zeal of his admirers, he will cease to be the wonder of the hour; that as soon as the secret of his plausibility is exposed he will suffer a more complete neglect than he will fairly deserve." These were ominous words, and coming from such a source they led many to expect that very soon some powerful hand would strip the mask from a pretender and consign him to speedy oblivion. Meantime, the lugubrious prophecy remained unfulfilled. Dr. Porter, however, continues to be of the same mind, and after this long time he comes forward and with unseemly malediction again foretells the unmasking of this pretentious writer, whom he elsewhere likens to a "dexterous juggler." Yet, instead of collapsing and vanishing in accordance with this portentous Porterian programme, Spencer emerges in a new field into which the President of Yale finds it necessary to follow him with a six-columned article in "The Independent." Some pleasant things are said of the "Data of Ethics" and its author, but Mr. Spencer is sharply indicted for not making enough of the metaphysical notion of personality. Dr. Porter declares: "Indeed, personality is a conception which is utterly foreign to any and every part of his theory, as it logically should be. This grand and damning defect will one day be discovered and confessed when the factitious glamour which now invests it is dispelled."

Theologians have ever been free in the application of damnatory expletives to scientific ideas which do not conform to their standards, and the President is here merely conforming to the long-prevalent custom of his party. But, so long as these execrable defects of Spencer's theories are yet spoken of as things to be "one day discovered," would it not be well to pretermit this little game of sinister augury, and be content to curse defects already discovered?

The President of the College of New Jersey has also paid his respects to the "Data of Ethics" in the "Princeton Review," but he is at wide disagreement with his brother of Yale. In fact, they are squarely antagonistic in their estimates of Spencer, past, present, and future. Dr. McCosh does not think that he is either a sham to be exposed, or a thinker to be soon forgotten. He opens his article by saying: "Herbert Spencer commands our respect by his terrible earnestness. He has an end to live for, and he lives for it. For it he has given up professional pursuits and profits (he was an engineer), and for many years immediate fame and popularity. For at least thirty years a grand system of speculative physics founded on the recent discoveries in biology has been developing in his brain, and he must unfold it and give it forth in spite of obstacles, with or without encouragement from surroundings in the world. He is to a large extent the author, and is certainly the organizer and the very embodiment, personification, and expression of development." Again Dr. McCosh says: "What may be the estimate of his philosophy at the end of this century I will not take upon myself to predict. As embracing so many es-

tablished facts, I believe there is much in his system which will abide; and I adhere to the opinion that 'his bold generalizations are always instructive, and that some of them may in the end be established as the profoundest laws of the knowable universe.'"*

That eminent logician and mathematician, Professor J. Stanley Jevons, has been recently reviewing the philosophy of J. S. Mill in a series of articles in the "Contemporary Review." In the November number he takes up Mill's "Utilitarianism," and considers his contributions to the subject of morality in relation to the present state of knowledge. He recognizes that Mill belonged to a past dispensation, and was incompetent to deal scientifically with those great moral problems by the handling of which Herbert Spencer has made a new epoch in philosophic thought. We give some of the closing passages of his article:

Such are the intricacies and wide extent of ethical questions, that it is not practicable to pursue the analysis of Mill's doctrine in at all a full manner. We can not detect the fallacious reasoning with the same precision as in matters of geometric and logical science. This analysis is the less needful, too, because, since Mill's essays appeared, moral philosophy has undergone a revolution. I do not so much allude to the reform effected by Mr. Sidgwick's "Methods of Ethics," though that is a great one, introducing as it does a precision of thought and nomenclature which was previously wanting. I allude, of course, to the establishment of the Spencerian theory of morals, which has made a new era in philosophy. Mill has been singularly unfortunate from this point of view. He might be defined as the last great philosophic writer conspicuous for his ignorance of the principles of evolution. . . . The whole tone of Mill's moral and political writings is totally opposed to the teaching of Darwin and Spencer, Tylor and Maine. Mill's idea of human nature was that we came into the world like lumps of soft clay, to be shaped by the accidents of life, or the care of those who educate us. Austin insisted on the evidence which history and daily experience afford of "the extraordinary pliability of human nature," and Mill borrowed the phrase from him. No phrase could better express the misapprehensions of human nature which, it is to be hoped, will cease for ever with the last generation of writers. Human nature is one of the last things which can be called "pliable." Granite rocks can be more easily molded than the poor savages that hide among them. We are all of us full of deep springs of unconquerable character, which education may in some degree soften or develop, but can neither create nor destroy. The mind can be shaped about as much as the body; it may be starved into feebleness, or fed and exercised into vigor and fullness; but we start always with inherent hereditary powers of growth. The non-recognition of this fact is the great defect in the moral system of Bentham. The great Jeremy was accustomed to make short work with the things which he did not understand, and it is thus he disposes of "the pretended system" of a moral sense: "One man says he has a thing made on purpose to tell him what is right and what is wrong, and that it is called a *moral sense;* and then he goes to his work at his ease, and says such a thing is right and such a thing is wrong. Why? Because my moral sense tells me it is." Bentham then bluntly ignored the validity of innate feelings, but this omission, though a great defect, did not much diminish the value of his analysis of the good and bad effects of actions. Mill discarded the admirable Benthamist analysis, but failed to introduce the true evolutionist principles; thus he falls between the two. It is to Herbert Spencer we must look for a more truthful philosophy of morals than was possible before his time.

The publication of the first part of his principles of morality, under the title "The Data of Ethics," gives us, in a definite form, and in his form, what we could previously only infer from the general course of his philosophy and from his brief letter on utilitarianism addressed to Mill. Although but fragments, these writings enable us to see that a definite step has been made in a matter debated since the dawn of intellect. The moral sense doctrine, so rudely treated by Bentham, is no longer incapable of reconciliation with the greatest happiness principle, only it now becomes a moving and developable moral sense. An absolute and unalterable moral standard was opposed to the palpable fact that customs and feelings differ widely, and Paley, on this ground, was in-

* This estimate Dr. McCosh had the sagacity to make and the courage to express many years ago in his "Intuitions of Mind."

duced to reject it. Now, we perceive that we all have a moral sense; but the moral sense of one individual, and still more of one race, may differ from that of another individual or race. Each is more or less fitted to its circumstances, and the best is ascertained by *eventual success*.

At the tail end of an article it is, of course, impossible to discuss the grounds or results of the Spencerian philosophy. To me it presents itself, in its main features, as unquestionably true; indeed, it is already difficult to look back and imagine how philosophers could have denied of the human mind and actions what is so obviously true of the animal races generally. As a reaction from the old views about innate ideas, the philosophers of the eighteenth century wished to believe that the human mind was a kind of *tabula rasa*, or *carte blanche*, upon which education could impress any character. But, if so, why not harness the lion, and teach the sheep to drive away the wolf? If the moral, not to speak of the physical characteristics of the lower animals, are so distinct, why should there not be moral and mental differences among ourselves, descending, as we obviously do, from different stocks with different physical characteristics? . . . . Many persons may be inclined to like the philosophy of Spencer no better than that of Mill. But, if the one be true and the other false, liking and disliking have no place in the matter. There may be many things which we can not possibly like; but, if they are, they are. It is possible that the principles of evolution, as expounded by Mr. Herbert Spencer, may seem as wanting in "geniality" as the formulas of Bentham. . . . Nevertheless, I fully believe that all which is sinister and ungenial in the philosophy of evolution is either the expression of unquestionable facts, or else it is the outcome of misinterpretation. It is impossible to see how Mr. Spencer, any more than other people, can explain away the existence of pain and evil. Nobody has done this; perhaps nobody ever shall do it; certainly systems of theology will not do it. A true philosopher will not expect to solve everything. But, if we admit the potent fact that pain exists, let us observe also the tendency which Spencer and Darwin establish toward its *minimization*. Evolution is a striving ever toward the better and the happier. There may be also infinite powers against us, but at least there is a deep-built scheme working toward goodness and happiness. So profound and widespread is this confederacy of the powers of good, that no failure, and no series of failures, can disconcert it. Let mankind be thrown back a hundred times, and a hundred times the better tendencies of evolution will reassert themselves. Paley pointed out how many beautiful contrivances there are in the human form tending to our benefit. Spencer has pointed out that the universe is one deep-laid framework for the production of such beneficent contrivances. Paley called upon us to admire such exquisite inventions as a hand or an eye; Spencer calls upon us to admire a machine which is the most comprehensive of all machines, because it is ever engaged in inventing beneficial inventions *ad infinitum*. Such, at least, is my way of regarding his philosophy.

Darwin, indeed, cautions us against supposing that natural selection always leads toward the production of higher and happier types of life. Retrogression may result as well as progression. But I apprehend that retrogression can only occur where the environment of a living species is altered to its detriment. Mankind degenerates when forced, like the Esquimaux, to inhabit the Arctic regions. Still in retrograding, in a sense, the being becomes more suited to its circumstances — more capable, therefore, of happiness. The inventing machine of evolution would be working badly if it worked otherwise. But, however this may be, we must accept the philosophy if it be true, and, for my part, I do so without reluctance.

According to Mill, we are little, self-dependent gods, fighting with a malignant and murderous power called Nature, sure, one would think, to be worsted in the struggle. According to Spencer, as I venture to interpret his theory, we are the latest manifestation of an all-prevailing tendency toward the good, the happy. Creation is not yet concluded, and there is no one of us who may not become conscious in his heart that he is no automaton, no mere lump of protoplasm, but the creature of a Creator.

RAILROAD CASUALTIES.

Our half century's experience with railroads is full of various instruction. Charles Francis Adams, Jr., has occupied himself with the lessons of railroad casualties. He has investigated them officially in Massachusetts, and studied them elsewhere, and he has made a little volume which he modestly calls

"Notes on Railway Accidents," but which is the first digest of information we have regarding great railway disasters, their causes, and the progress of security in this mode of travel. The book is interesting and valuable, no less for its reflections and conclusions than for its well-collated facts.

Mr. Adams begins by calling attention to the melancholy fact that there are few things of which nature or man is more lavish and careless than human life. There is really but little care about the waste of life so long as the fatality is unobtrusive. The destruction of life by war is as nothing to that by intemperance, bad sewerage, and worse ventilation; but, as it does not come by crush and shock, it attracts small attention. Railroad "horrors" make a strong impression upon the public mind; and each fresh catastrophe, by arousing public opinion, by inciting the courts to hold the companies to a more rigorous responsibility, and, above all, by the damage and detriment they work to the corporations, leads to increasing vigilance and greater security, "until it has been said, and with no inconsiderable degree of truth, too, that the very safest place into which a man can put himself is the inside of a first-class railroad-carriage, on a train in full motion."

But, on the other hand, all these appalling disasters seem to have been necessary to secure the improvement of the railway system. There can be no greater mistake than to suppose that men are guided and governed by reason. Most of them are creatures of habit, stupid, sluggish, and prejudiced, and can only learn slowly through calamitous experience. As Mr. Adams says, "To bring about any considerable reform, railroad disasters have, as it were, to be emphasized by loss of life." Indeed, the most instructive part of his volume is the profuse illustration it affords of that inveterate stolidity on the part of railroad managers and officials which nothing could overcome but slaughter, public indignation, murmurs, pecuniary losses—and all this over, and over, and over again—while it has proved impossible even yet to get rid of some of the most serious sources of danger.

The bell-cord for signaling the engineer is a simple device for an important purpose, but it has had a curious history. Nothing certainly would seem to be more essential than for a passenger in case of grave accident to be able to communicate instantaneously with the engine-driver of his train. This is perfectly accomplished by the bell-cord, which has been accordingly long in use in this country. Yet it was not used in England, and its adoption, singular to say, was actively resisted, although they had nothing else to replace it. Mr. Adams says, "An English substitute for the American bell-cord has for more than thirty years set the ingenuity of Great Britain at defiance."

In 1857 the British Board of Trade issued a circular to the railroad companies, pointing out the dangers that arise from lack of proper signal-connection. They say: "From the beginning of the year 1854 down to the present time (December, 1857) there have been twenty-six cases in which either the accidents themselves or some of the ulterior consequences of the accidents would probably have been avoided had such a means of communication existed." But there had not been funerals enough to enforce the recommendation. To get a string attached to a bell for the safety of travelers required a succession of shocks to thrill the country; and they came, of course, in due time. Not only did accidents continue from the setting fire of carriages and throwing them from the rails, but several dreadful instances of assault by maniacs, men with delirium tremens, and criminals, and even outright murder took place, which would undoubtedly have been avoided if there had been any means of communication to stop the train. Sev-

eral examples are given by Mr. Adams of these terrible occurrences, which "indicate the tremendous nature of the pressure which has been required to even partially force the American bell-cord into use in that country."

But the stolid indifference of railroad conservatism is by no means confined to England. Mr. Adams remarks: "It will not do for the American railroad manager to pride himself too much on his own greater ingenuity and more amicable disposition. The Angola disaster has been referred to, as well as that at Shipton. If the absence of the bell-cord had indeed any part in the fatality of the latter, the presence in cars crowded with passengers of iron pots full of living fire lent horrors almost unheard of to the former. The methods of accomplishing needed results which are usual to any people are never easily changed, whether in Europe or in America; but certainly the disasters which have first and last ensued from the failure to devise any safe means of heating passenger-coaches in this country are out of all proportion to those which can be attributed in England to the absence of means of communication between passengers on trains and those in charge of them. There is an American conservatism as well as an English; and when it comes to a question of running risks it would be strange indeed if the greater margin of security were found west of the Atlantic. The security afforded by the bell-cord assuredly has not as yet, in this country, offset the danger incident to red-hot stoves."

Mr. Adams gives an interesting account of the introduction of various other safety appliances on railroads, and shows that they were mostly repetitions of the bell-cord experience. Among these improvements none are more important than the brakes under the control of the engineer, for quickly stopping trains running at high speed. The American Westinghouse brake, by which an air-pump, attached to the boiler of the locomotive and controlled by the engineer, forces atmospheric air through tubes running under the cars, by which the brake-blocks are pressed against the wheels, is incontestably the most perfect contrivance for quickly stopping trains that has yet been invented, as by means of it the hand of the engine-driver is in fact upon every wheel in the train. This contrivance was of course delicate, and was at first liable to get easily out of order; but it was gradually perfected so as to become automatic and thoroughly trustworthy. "In this country, the superiority of the Westinghouse over any other description of train-brake has long been established through that long preponderance of use which in such matters constitutes the final and irreversible verdict." But in Great Britain its introduction was vigorously resisted, and, as it was energetically pushed, there grew up a war among the different contrivances, to which Mr. Adams devotes an interesting chapter under the title of "The Battle of the Brakes." A royal English commission on railroad accidents was appointed, and undertook a series of competitive trials with the different inventions. "Eight brakes competed, and a train consisting of a locomotive and thirteen cars was specially prepared for each. With these trains some seventy runs were made, and their results recorded and tabulated; the experiments were continued through six consecutive working-days. The result of the trials was a very decided victory for the Westinghouse automatic, and upon its performances the commission based its conclusion that trains ought to be so equipped that in cases of emergency they could be brought to rest when traveling on level ground at fifty miles an hour within a distance of 275 yards." The result was sufficiently decisive, and the Board of Trade urged upon the English companies the adoption of the brake which had

proved to be most efficient for its purpose. But there were too many parties interested in rival devices, and the superior one came into use, but very slowly. It did make progress, however, and we are told that the issue is now narrowed down to a struggle between two American brakes, the Westinghouse and the Smith vacuum, which has been its strongest rival.

As to the comparative safety of travel on the railroads in England and in this country, it is conceded that the former have the advantage, although exactly to what extent it is impossible to say, owing to the gross incompleteness of American statistics. But the causes of accidents act very unequally in the two countries. For example, while from failure of bridges, viaducts, or culverts, there were, in six years, in England, only twenty-nine accidents, there were in this country, for the same time, one hundred and sixty-five accidents due to similar causes. The English lead in accidents from collisions of trains, and we in accidents from trains being thrown from the track. "The English collisions are distinctly traceable to constant overcrowding; the American derailments and bridge accidents to inferior construction of our road-beds."

The subject of railroad statistics, including accidents, has received more attention in Massachusetts than elsewhere in this country. The following statement by Mr. Adams will excite some surprise: "During the four years 1875–'78 it will be remembered a single passenger only was killed on the railroads of Massachusetts in consequence of an accident to which he, by his own carelessness, in no way contributed. The average number of persons annually injured, not fatally, during these years, was about five; yet during the year 1878, excluding all cases of mere injury, of which no account was made, no less than fifty-three persons came to their deaths in Boston from falling down stairs, and thirty-seven more from falling out of windows; seven were scalded to death in 1878 alone. In the year 1874, seventeen were killed by being run over by teams in the streets. During the five years, 1874–'78, there were more persons murdered in the city of Boston alone than lost their lives as passengers through the negligence of all the railroad corporations in the whole State of Massachusetts during the nine years 1871–'78; although in these nine years were included both the Revere and the Wollaston disasters, the former of which resulted in the death of twenty-nine and the latter of twenty-one persons.

The most prolific source of railroad accidents is reckless walking and sauntering upon the tracks—a practice in violation of the law, and for which the companies are not responsible. Walking upon the railroad-track is, in this country, regarded as a kind of right of the American citizen which he pays for liberally, nearly fifty per cent. of all accidents which occur being due to this cause. Under the English monarchy the people are kept off the tracks more effectually, and the accidents from this source are accordingly only about seven per cent. of the whole number.

REMOVING THE BARRIERS OF COMMERCE.

We print a translation of the address delivered before the International Congress at Paris, by M. Charles de Fourcy, on the several projected routes of an Interoceanic Ship-Canal across the Isthmus of Darien. M. de Fourcy is a distinguished French engineer, and Inspector-General of Roads and Bridges in France, an eminent and responsible position in that country. He was a delegate to the Congress, a member of its "Technique" Committee, and President of the second Sub-Committee into which it was divided to simplify its labors. On the afternoon of the day preceding the final vote he reviewed

the subject in a speech which was listened to with close attention, and, as we are informed by Mr. Nathan Appleton, who was a critical observer of the proceedings, his statement of the relative advantages and disadvantages of the different contemplated lines was undoubtedly influential in determining the vote of the Congress in favor of the Panama route.

We have had engraved, to accompany the article, two very instructive maps, one representing the location of the different routes under consideration, and the other showing the relation which this project bears to the oceanic commerce of the world.

Without venturing to decide which is the best route—a question that belongs to the engineers—we are clear as to certain of the considerations which should have weight in determining it. That the canal must come is inevitable. The Isthmus barrier is a hindrance to commerce—a kind of natural tariff that must be removed in the interest of advancing free trade. It must disappear with other old restrictions on the world's exchanges. It will be a step forward in civilization, and is in the strictest and largest sense an international affair. Commerce is pacific; war and the military spirit are its deadly foes. It is, therefore, of the first necessity that the enterprise should be "hedged about with ample international guarantees of perpetual neutrality." The opening of a water-way across the narrow strip of land that separates two oceans is a world's measure, and ought not to be complicated with any local political considerations. The talk about "patriotism" and the "Monroe doctrine" in connection with this great project is therefore impertinent. It springs from the same narrowness of national feeling that has killed our foreign commerce by prohibiting American citizens from buying ships where they please, and it is a policy which will be condemned by all liberal-minded people.

LITERARY NOTICES.

Is Life worth Living? By William Hurrell Mallock. New York: G. P. Putnam's Sons. Pp. 323. Price, $1.50.

This work, which has recently attracted considerable attention, is a sort of theological manifesto directed against the tendencies of modern science. Those who have arrived at what may be called the conundrum-stage of mental development, and do not object to irreverent impudence, may be pleased with it. Its author is a young English writer, who made a hit with his impertinent satire, "The New Republic," and, having sustained his reputation by various sensational contributions to the periodicals, he now comes jauntily forward with his grand question as to the worth of life, to which his book is an answer. He anticipates the work of the day of judgment by summing up the experiment of universe-making and estimating the net value of the result.

Mr. Mallock is well skilled in rhetorical and dialectic art, and writes in a lively and spirited way. To the amusement-seeking, novel-reading mind, ever on the lookout for a new sensation, and with a frivolous side-interest in religious matters, we should say that the book may be entertaining; but, viewed as a deliverance of sober thought addressed to sensible people, it is a book of nonsense.

The pert effrontery of Mr. Mallock's question, and the unutterable stupidity of the conclusion to which his logic brings him, are apparent at a glance. The question whether life is worth living, of course involves the question of the value of existence and the universe, for life is the grand outcome of the order of Nature. It is something that has arisen by slow degrees and through innumerable forms and grades, during immeasurable time, and is the agency by which the human mind has come into being and reached its present perfection. Life is therefore the thing that has been aimed at, in the onworking of universal law, for more millions of years than we are at liberty to talk about. Life is not a foreign and mysterious something that has been thrust into the system of nature, but

it is itself the property and purpose and highest issue of that system. The completest type of organism has been reached through countless ages of struggle and profuse destruction of the lower grades of creatures. In those distant periods Mallock was only a potentiality, and it has been a very expensive process to bring him to pass. A few years ago Mallock was but a globule of English protoplasm, involving whatever life-possibilities heredity had imparted to it. He grew from a germ until his brain acquired the power of thinking and asking questions. He is a product of that long process of life-unfolding that makes him now competent to reason about the universe, and to deduce from it ideas of the existence and attributes of God. Having been brought forth in this way as a result of cosmical operations to which no bounds can be discovered either in time or space, he looks about him and asks whether the whole concern is not a blunder and a fizzle. And the question he raises he is abundantly ready to settle. We might perhaps ask for some suspension of judgment on the ground that, as the universe is in a state of evolution, and has come up from a lower or more worthless condition to a higher or more worthy one, it will go on increasing in worthiness so as finally to become tolerable, if not valuable. Granting that Mallock is no great result, possibly we might, after a time, get something better than Mallock. But he allows no postponement of judgment. He has all the data of the case, and is prepared with a final conclusion. He argues the subject through three hundred and twenty-three pages of his book, and the upshot is a contingent answer. Life is worth living, if you belong to a particular theological school; if you belong to any other theological school, or to no school at all, it is not worth a pin. If you are a Methodist, or a positivist, or a pagan, life is not worth living, but if you are a Roman Catholic, it is. When the mental evolution of man lands him in the bosom of the Papal Church, the long process was well worth while; when it leaves him elsewhere, it is a dead failure. We have here the last brilliant exploit of the theological mind in its warfare with modern science.

The logical implications of Mr. Mallock's position are somewhat curious. He holds that there is no sound morality without Christianity, and no Christianity without a hell. When the heretic and the unbeliever and all beyond the pale of Mother Church die, they sink into perdition, but when the true Catholic dies he has a passport to the happiness of heaven. Now, one would think that this is decisive as to which parties should most prize the continuance of life. Life ought to be best worth living to those who have most to lose when it terminates, and least worth living to those who have everything to gain when it comes to an end. But great is the mystery of logic to those who vacate their reason in deference to infallible authority.

NAVAL HYGIENE: HUMAN HEALTH AND THE MEANS OF PREVENTING DISEASE. With Illustrative Incidents derived from Naval Experience. By JOSEPH WILSON, M. D., Medical Director, U. S. N. Second edition, with Colored Lithographs. Philadelphia: Lindsay & Blakiston. 8vo, pp. 274. 1879. Price, $3.

WHEREVER human beings live together in considerable numbers for any length of time, we expect the conditions of health will soon become impaired unless constant and well-directed efforts are made for their protection; and, in spite of the popular notion to the contrary, life on shipboard is no exception to the rule. Indeed, there are few places where sanitary precautions are more necessary, or where they may be applied with better effect.

The present work is intended as a help in this direction, and contains much that, if brought together in a compact form, would be of service to medical officers and others filling responsible positions in the naval and mercantile marine. The author has chosen, however, to include a great deal that has only a remote relation to the subject, and that here serves merely to encumber and obscure what could otherwise be made practically available. Fifty pages, for example, are given to zoölogy and botany, while the immensely more important subjects of clothing, food and its preservation, the storage and management of the water-supply, and the cleansing and ventilation of the ship, are compressed into an almost equal space; and much of this even is taken up with matter

that has little bearing on the topic under discussion.

The chapter on epidemics adds nothing whatever to our knowledge of their causes or prevention, says not a word concerning the measures requisite for their management when occurring on shipboard, and leaves us in doubt as to whether the author is even acquainted with the results of modern investigations on the subject. Had he been, we should scarcely expect to find such a paragraph as this on epidemic influences: "The cause and nature of this epidemic influence are quite unknown. The most ancient theory is as true as any God so ordained it; has thus organized his creatures. Anciently, these diseases were mostly attributed to his wrath; and certainly they mostly result more or less directly from violations of his known laws. When we seek for the instruments of his will in this matter, we get into a labyrinth of guesses, and ingenious and plausible theories, in which hydro-carbons, fermentations, organic germs, microscopic animalcules, and cryptogamic vegetations are made prominently to figure. They nearly all refer to impurities or distemperatures of the atmosphere."

After this, we are not surprised to find the following statement concerning the spread of yellow fever: "In regard to the question of quarantine in this disease, we may safely say that all restraints that prevent the sick from reaching a healthy locality are absurd, and, with our present knowledge on the subject, outrageously cruel—little better than deliberate murder. A yellow-fever patient, even carrying his clothing and bedding with him, has never been known to communicate the disease to another person in a healthy locality, and the experiment has been tried thousands of times."

Chapters XXIV. to XXVIII. inclusive are devoted to certain endemic diseases, among which scorbutus and typhus are the only ones particularly liable to occur on shipboard, and even in the case of these there is a conspicuous absence of specific directions for their prevention. Why such diseases as plica polonica, goitre, elephantiasis, cholera infantum, milk-sickness, and puerperal fever should be discussed in a work on naval hygiene, we fail to understand; and for the addition of an appendix, devoted exclusively to the subject of weights and measures, there seems no other explanation than a desire to fill up the book. Indeed, from beginning to end, the idea is forced upon us that bulk rather than quality has been the principal object.

As before remarked, there are scattered through the pages of the book many good suggestions, that might be made of use had readers the time and patience to hunt them out; all, however, so far as we have observed, may be found in other works on hygiene, and in a far more accessible and less costly shape.

THE SILK GOODS OF AMERICA: A Brief Account of the Recent Improvements and Advances of Silk Manufacture in the United States. By WILLIAM C. WYKOFF. Published under the Auspices of the Silk Association of America. New York: D. Van Nostrand. 1879. Pp. 120. Price, $1.50.

THE author of this work claims that American silk goods are better as well as cheaper than foreign, and that it is time their actual merits were laid before the public. Every wearer of silk goods, or consumer of sewing-silk and twist, will be interested in the information conveyed in the various chapters upon raw silk; upon sewings and twist; upon weaving; upon black dress-goods; various piece-goods; spun silk; handkerchiefs and ribbons; trimming and *passementerie;* silk laces; dyeing, etc.

From the profusion of interesting information with which the pages of this volume are crowded, we extract quite at random the following. The lengthier statements and explanations are, perhaps, more instructive than the brevities we have chosen.

We are told that the manufacturer wants reeled silk and not cocoons. Its value depends upon the way it is reeled, which is best done at a filature, where cheap skilled labor can be obtained. There are no filatures in this country. Our raw silk comes from abroad—about twenty-four per cent. from Europe and the rest from Asia. The Japanese now have filatures, and send us silk equal to the best from Europe. The coarse, inferior silks are kept at home, and America gets the best and finest. Raw silk is costly and of small bulk, so that its freight

is trifling, though it comes so far. By the opening of direct routes to Asia, our silk comes more quickly, thus diminishing the cost of insurance, of interest on capital, and the risk of change of price while on the way. Our importation was greater last year than ever before, being 1,590,666 pounds. The market for silk goods is little affected by the fluctuation in price of raw silk.

The manufacture of silk thread has reached a point with us that defies competition. The superiority of our spooled silk over the foreign was apparent at the Centennial Exposition, and the Europeans have lost their trade here. At first our sewing-silk was made in skeins, but the sewing-machine has revolutionized this branch of the business. Our silk thread did not at first permit the shuttle to pass through the loop that was carried down by the needle; but after many experiments it was found that, by twisting the strands from right to left instead of the other way, it answered the purpose perfectly, and this is machine-twist. The most sedulous care is taken in the manufacture and dyeing. "There is still some difference of opinion in the trade as to whether one ounce of dye to twelve ounces of pure silk, or four to twelve, will give the most serviceable thread. The two kinds are known as thirteen-ounce or pure dye, and sixteen-ounce or standard dye. The standard of purity is closely adhered to, and has helped us to win in the struggle with the foreign thread. Few European threads equal our own in purity. In making colored silk thread, we have reached a high point of delicacy. If we depended for this upon European mills, the color desired would be out of fashion before the thread arrived.

As to the weaving of silk, it is said that we are obliged to import the very best raw silk, owing to the high price of labor here—poor silk requiring great cost in labor. "It costs five times as much to tie a knot here as in France." In the best silk, the thread is not lumpy; but, in weaving the lumpy thread of poor silk, the weaver is constantly busy picking off the imperfections. This is in hand-weaving, which is the prevalent mode in Europe. We use power-looms. In the manufacture of plain black-silk goods we have a system of our own which has grown up in this country. We quote the following method of testing the purity of silks: Ravel out a few threads and pass them through and over the fingers. "In heavily dyed silk the particles of dye will make the threads feel rough and lumpy to the touch. Then by wetting the lint, the goods weighted by dye will be readily distinguished by the dye coming out under pressure. Another simple but effective test of purity is to burn a small quantity of the threads. Pure silk will instantly crisp, leaving only a pure charcoal; heavily dyed silk will smolder, leaving a yellow, greasy ash." One of our most sanguine manufacturers declares his belief that within ten years the dress-silks of this country will bear a higher reputation than those made anywhere else in the world.

In figured dress-silk goods, raw material bears a greater proportion to labor. Our designs are original, changing in color and pattern with the seasons. They are mostly made on power-looms, are firm, serviceable, and very cheap. The Jacquard machines on which they are woven came at first from England and France; but they are now wholly made here, and adapted to our requirements. They are the same in principle but run more smoothly, and can be applied to more intricate patterns, and obtain a higher speed. In making satins and grenadines we have also produced great improvements. Although these goods are so unlike, we were the first to make grenadines with satin stripes, and have added a brocaded pattern that permeates both. We do not yet succeed with silk velvet. Refinishing is a large business here. Heavy calendering-machines of 300 tons' power are used, and the pressure can be varied from five pounds to 60,000. Some goods go through hot rolls and some through cold, and the surface of the roll may convert plain silks into striped ones or into *moire antique*. The proper pressure gives to brocade definiteness of outline, and to satin its full luster. Damaged goods acquire freshness, old fashions are changed to new, and "hard silk" to soft, by the finishing process. In the matter of umbrellas we are at last achieving success. Some made here, from ferule to handle, have survived the storms of successive years, and are still fit for service.

Spun silk is made from "waste" silk. The sources of waste silk are, cocoons of

irregular formation, the tangled floss from filatures, and raw silk more or less tangled in the silk-mill. It is pure silk that can not be reeled. It is prepared for spinning by the most delicate processes, and when ready looks like the whitest of combed fleeces, and has a luster equal to that of spun glass. It can be spun with perfect smoothness and of any size. Spun and reeled silks are becoming more and more interchangeable in the manufacture of fabrics. The two methods of making cheap, showy silks are either by weighting slight material with dyestuff, or by using spun silk. Brocades for ball- and wedding-dresses are often of spun silk.

American-made handkerchiefs, scarfs, neckties, and millinery goods, compete successfully with the foreign supply, and keep down prices for consumers. In ribbons our success is complete. Only inferior ribbons are now imported in any quantity. In comparison with ours the foreign ribbons are overweighted and of inferior silk. The designs originate in our own factories, and are much admired abroad. They are made upon power-looms, of which we have the best in the world. In the making of trimmings and of lace, the details given in this work are very interesting, but we have no more space at our command. We must also omit the subject of dyeing, which, though the last in order, is by no means the least interesting.

The remainder of the volume is taken up with statistics of the silk manufacture; and the "Seventh Annual Report of the Silk Association of America," in which the progress of the past year is summarized, is also added.

A Contribution to the Geology of the Lower Amazonas. By Orville A. Derby, M. S. Pp. 24.

The scientific world is chiefly indebted to the late Professor Hartt for recent accurate and detailed investigations of the geological structure of eastern Brazil, and of the lower Amazon and its tributaries. But the untimely death of Professor Hartt, with various other causes, has delayed the publication of the extensive reports he had prepared; and we have in the present pamphlet a *résumé* of the work which they cover, furnished by his friend and assistant Mr. Derby. The author also includes the results of some of his own researches in the same field, made subsequently to those of Professor Hartt. The great valley of the Amazon, according to these investigators, first appeared in early Silurian times as a wide strait between two islands or groups of islands, one forming the base of the Brazilian plateau, and the other that of the plateau of Guiana. The rise of the Andes converted the western part of the strait into a basin, and subsequent oscillations have determined the character and succession of deposits in the geological development of the region. The evolution of the great valley terminated with the formation of the vast flood-plain which now covered with forest extends from the Atlantic to the foot of the Andes.

Primitive Manners and Customs. By James A Farrer. New York: Henry Holt & Co. Pp. 315. Price, $1.75.

This book will do very well as a stepping-stone to the ethnological treatises of Tylor, Lubbock, Bancroft, and Peschell, on the life of the lower races of mankind. It gives an entertaining account of the ideas, habits, and peculiarities of savage and half-civilized tribes, taking up in successive chapters their "Myths and Beliefs," their "Modes of Prayer," "Proverbs," "Moral Philosophy," "Political Life," "Penal Laws," "Wedding Customs," "Fairy Lore," and "Comparative Folk Lore." The author writes in a liberal spirit, but rather avoids the controversial topics raised by investigators in this field. In his introduction he remarks:

The vexed question, whether savage life represents a primitive or a decadent condition, whether it represents what man at first everywhere was, or only what he may become, has throughout the following chapters been avoided, that controversy being regarded as "laid" by the exhaustive researches of Mr. Tylor and other writers. But, while the state of the lowest modern savages is taken as the nearest approximation we have of the primitive state from which mankind has risen, it is not pretended that the state of any particular tribe may not be one to which it has fallen. As the low position of many Bushmen tribes is quite explicable by their long border warfare with the Dutch, and the consequent cruelties they were exposed to, or as the state of many Brazilian savages may be traced to similar contact with the Portuguese, so any case of extreme savagery may be the re-

sult of causes whose operation has no historical or no written proof to attest them. The gigantic stone images on Easter Island, or the great earthworks in America, are among the proofs that but for such material traces of its existence it is possible for a whole civilization to vanish, and to leave only the veriest savages on the soil where it flourished. As we know that Europe was once as purely savage as parts of Africa are still, and can conceive the cycle of events restoring it to barbarism, so in the depths of time it may have happened in places where no suspicion of such a history is possible. As the surface of the earth seems subjected to processes of elevation and subsidence, land and sea constantly alternating their dominion, so it may be with civilization, destined to no permanent home on the earth, but subsiding here to reappear there, and varying its level as it varies its latitude.

As the practical infinity of past time makes it impossible to calculate the influence exercised in different parts of the world by migrations, by conquests, or by commerce, except within a very limited period, so it precludes any definite belief in ethnological divisions, and relegates the question of the unity of the human race, like that of its origin, to the limbo of profitless discussion. No characteristic has yet been found by which mankind can be classified distinctly into races: and with all the differences of color, hair, skull, or language, which now suffice for purposes of nomenclature, it remains true that there is nothing to choose between the hypothesis that we constitute only one species and that we constitute several. The world is so old as to admit of several divergences from a single original type quite as wide as any that exist; while, on the other hand, similarity of customs (such, for instance, as that Tartars in Asia, Sioux Indians in America, and Kamschadels should all regard it as a sin to touch a fire with a knife) fall us as a proof of a unity of origin, in the face of our ignorance of prehistoric antiquity.

Should he have succeeded in making any one think better than before, with more interest and sympathy of those outcasts of the world whom we designate as savage, something will at least have been done to claim for them a kindlier treatment and respect than in popular estimation they either deserve or obtain.

PAPERS READ BEFORE THE PI ETA SCIENTIFIC SOCIETY, 1878–'79. Rensselaer Polytechnic Institute, Troy, N. Y. Pp. 69.

THIS is a collection of ten papers on various subjects, most of which fall under the head of engineering. The first, by S. Edward Warren, on "Graphic Science in Text-book and Teaching," is an explanation of "the idea and intended use" of each volume of a series of text-books prepared by the author on this subject. The second is a technical paper by Hugo Gylden, Director of the University Observatory, of Stockholm, "On the Relations between the Number, Brightness, and Relative Mean Distances of the Fixed Stars as seen from the Earth," translated by Professor E. S. Holden, of the Washington Naval Observatory and Lieutenant Eric Bergland, U. S. Engineer Corps. Among the remaining papers, "Iron and its Uses in Permanent Structures," by C. J. Bates, and "Tides in the Upper Hudson," by John A. Ferris, are of considerable popular interest. A list of the members of the society is appended.

AMERICAN ORNITHOLOGY; OR, THE NATURAL HISTORY OF THE BIRDS OF THE UNITED STATES. Illustrated with Plates made from Drawings from Nature. By ALEXANDER WILSON and CHARLES LUCIEN BONAPARTE. Philadelphia: Porter & Coates. Pp. 788. Price, $7.50.

THIS book does not sufficiently explain itself. There are two volumes bound in one; there are prefixed to it twenty-seven plates containing three or four hundred engravings of birds; there is Baird's list of American species of 1856; and a biography of Alexander Wilson, made up chiefly of his letters. Two names appear upon the title-page as authors, but, if there is any statement of their respective shares in the production of the work, we have failed to observe it.

Alexander Wilson, the ornithologist, was a Scotchman, born in 1766, the son of a distiller, and who himself became a weaver. He early dabbled in poetry, and emigrated to Pennsylvania in 1794. He maintained himself at first by peddling and teaching school. During his journeys he became interested in birds, and at length devoted himself to that branch of natural history. He learned drawing, coloring, and etching, and projected a comprehensive work on American birds. Having prepared a large number of fine illustrations, he made tours through the country to extend his ornithological observations and to get subscribers to his work, which was to appear in successive volumes, and to cost altogether $120. He was but poorly sustained, getting many compliments for the beauty of the pictures he presented, with but very little substantial support. The first volume appeared in 1808. He had completed the publication

of seven volumes when he died, in 1813, and the eighth and ninth volumes were subsequently edited by George Ord.

Charles Lucien Bonaparte, son of Lucien Bonaparte, the second brother of Napoleon, was born in Paris in 1803, and in 1822 he married the daughter of Joseph Bonaparte and went to Philadelphia, where he joined his father-in-law. He was an ardent naturalist, and devoted himself especially to the subject of birds. He published "American Ornithology," in four volumes (1822–'33), thus continuing Wilson's great work. He added descriptions of over one hundred new species of birds discovered by himself, and which are designated in the lists of the work before us.

The present popular edition of "American Ornithology," now issued in one portly volume by Porter & Coates, is evidently based upon the elaborate publications of these two naturalists, and the work has a permanent interest, both from its early and original observations, and as representing a portion of the history of American science.

THE ROSICRUCIANS: Their Rites and Mysteries, with Chapters on the Ancient Fire and Serpent Worshipers, and Explanations of the Mystic Symbols represented in the Monuments and Talismans of the Primitive Philosophers. 300 Illustrations. By HARGRAVE JENNINGS. New York: J. W. Bouton. Pp. 372.

WE gather but little more from looking over this book than is conveyed by the title. It has a great number of mysterious symbolic pictures; and its text is of mysterious people and mysterious things. There *may* be wisdom in it, nevertheless.

THE ANTIQUITIES AND PLATYCNEMISM OF THE MOUND-BUILDERS OF THE STATE OF WISCONSIN. By J. M. DE HART, M. D. Pp. 15. Illustrated.

IN this pamphlet Dr. De Hart briefly describes a few of the more remarkable mounds belonging to a group found near Lake Mendota, in the State of Wisconsin. Like the mounds in other parts of the State, these are mainly of two sorts, animal mounds, or those made in imitation of the forms of animate objects, and mounds of circular or oblong form, with a more or less conical or pyramidal elevation, some of which contain human and other remains. Of the former, which usually represent the animals they are meant to imitate, on an immensely extended scale, the author describes one that is shaped like a bird with wings expanded, each wing measuring about 300 feet in length; another in the form of a squirrel with a tail over 500 feet long; a third representing a deer; a fourth a bear, etc.

The largest of the circular mounds was opened by the Doctor, and found to contain, besides ashes, flints, and other *débris*, three human skeletons, presenting in each case types of structure characteristic of the mound-builders. The most marked of these peculiarities, viz., the flat shin-bones, and the perforation at the inferior extremity of the humerus, are discussed by the author.

THE SILKWORM. Being a Brief Manual of Instruction for the Production of Silk. With Illustrations. By Professor C. V. RILEY. Washington, 1879. Pp. 31.

THIS forms Special Report No. 11 of the Department of Agriculture, of which at the time of its publication Professor Riley was entomologist. It opens with an introduction in which the causes that have hitherto retarded the growth of the silk industry in this country are pointed out; and the subject of profits in the different branches of the business quite fully considered. Next we have an interesting and instructive account of the natural history of the silkworm, including its diseases; followed by directions for rearing, and for the management required in order to obtain the largest returns, either in silk or eggs. The operation of reeling both by the old and the improved methods is described; and the pamphlet closes with a brief description of the food-plants of the silkworm. A glossary is appended, explaining the few technical terms the author was obliged to employ.

THE GEOLOGY OF THE DIAMONTIFEROUS REGIONS OF THE PROVINCE OF PARANA, BRAZIL. By ORVILLE A. DERBY, M. S. Pp. 8.

THIS short paper contains a good many interesting facts about the geological relations of the diamond and the methods adopted in mining for them. They are found in

the valley of the Zibagy and tributary streams, in the sands, in pot-holes, and in gravel-banks. The diamonds appear to have been washed out of the Devonian sandstone of that region, but the author thinks they were previously derived from metamorphic rocks, and deposited in the sands which afterward went to form these sandstones. That they did not originate in the latter is proved, he thinks, by the fact that it contains no traces of metamorphism or of crystallization.

FIRST STEP IN CHEMICAL PRINCIPLES. An Introduction to Modern Chemistry, intended especially for Beginners. By HENRY LEFFMAN, M. D. Philadelphia: Edward Stern & Co. Pp. 52. Price, 50 cents.

A BEGINNER of some maturity of mind, say a young medical student, who knew nothing whatever of the subject, might derive advantage from reading over this brief introduction; but it is not a "First Step" in any sense that it could be used in a primary school to start young beginners. It contains a very readable summary of chemical principles, but they are presented in the elaborated thought and technical language of the developed science.

THE YOUNG FOLKS' CYCLOPÆDIA OF COMMON THINGS. By JOHN D. CHAMPLIN, Jr. With numerous Illustrations. New York: Henry Holt & Co. Pp. 690. Price, $3.

MR. CHAMPLIN has here hit upon an excellent idea, and has carried it out very successfully. There was room for a popular book on common things much more full than the current "familiar science" manuals. A great deal of miscellaneous information on ordinary objects and subjects has been collated and digested in alphabetical order convenient for reference, and the editor is right in calling attention at the outset to the need of encouraging in the young the practice of consulting works of reference. The volume will be found most useful in families, as both the knowledge it imparts and the form of its presentation are well suited to satisfy the curiosity of young minds. A good deal of information is given about the common sciences, such as astronomy, chemistry, physics, natural history, and physiology, and about heat, light, air, electricity, and the parts and operations of the human system. There is much about the modes of manufacture of common articles, and the natural history of the more familiar and important animals and plants is fully presented. The book is compiled with judgment, Mr. Champlin having undergone his apprenticeship at this kind of work on the "American Cyclopædia." We are glad to notice that Holt puts the book at a quite reasonable price.

TWENTY LESSONS IN INORGANIC CHEMISTRY. By W. G. VALENTIN, F. C. S. G. P. Putnam's Sons. Pp. 184. Price, $1.

THIS claims to be an elementary book for students to begin with, but the beginning must be in the old lecture-room form of instruction. The author says: "It is not enough, as every teacher knows, to exhibit experiments before a class, unless they are made subservient to explain the theory of the science, and to place it on a sound basis. All theoretical explanations should be based upon experiments which fix it upon the memory. This is the plan which I have laid down for my guidance." As might therefore be expected, the book is filled with illustrations and descriptions of lecture-room experiments, and the usually accompanying explanations and information. It is clear, accurate, and well executed.

THE VALUE OF LIFE. A Reply to Mr. Mallock's Essay, "Is Life worth Living?" New York: G. P. Putnam's Sons. Pp. 253. Price, $1.50.

AN anonymous writer, thinking Mr. Mallock's book worth answering, has replied to his arguments very fully and ably in this volume. The book is written from the Positivist point of view, in the more special sense of the term. By Positivism, Mr. Mallock means those later tendencies and theories of science which bear upon the higher questions of religion, morality, and polity, and as illustrated in the writings of such thinkers as Clifford, Huxley, Tyndall, and Mill, but Mr. Mallock's critic rather means by "Positivism" the doctrines of Comte; and this reply is chiefly interesting as dealing with Mr. Mallock's questions from that point of view.

PUBLICATIONS RECEIVED.

The Mound-Builders. By J. P. Maclean. Illustrated. Cincinnati: Robert Clark & Co. 1879. Pp. 233, with Map. $1.50.

The Arctic Voyages of Adolf Erik Nordenskjold, 1858-1879. With Illustrations and Maps. London: Macmillan & Co. 1879. Pp. 447. $4.50.

A Text-Book of Physiology. By M. Foster, M. D., F. R. S. With Illustrations. Third edition, revised. London: Macmillan & Co. 1879. Pp. 730. $3.50.

The Native Flowers and Ferns of the United States. By Thomas Mehan. Vol. I. Parts I. to VIII. Illustrated.

Insect Lives, or Born in Prison. By Julia P. Ballard. Cincinnati: Robert Clark & Co. 1879. Pp. 97. $1.

Electricity, as related to Medicine and Surgery. By A. D. Rockwell, M. D. New York: William Wood & Co. 1879. Pp. 99. $1.

American Health Primers. The Throat and the Voice. By J. Solis Cohen, M. D. Pp. 159. The Summer and its Diseases. By James C. Wilson, M. D. Pp. 160. Winter and its Dangers. By Hamilton Osgood, M. D. Pp. 160. Philadelphia: Lindsay & Blakiston. 1879. 50 cents each.

Report of the Geology of the Henry Mountain. By G. K. Gilbert. Washington: Government Printing-Office. 1877. Pp. 160. 5 Maps.

Report on the Lands of the Arid Region of the United States. With a more Detailed Account of the Lands of Utah. By J. W. Powell. Second edition. Washington: Government Printing-Office. 1879. Pp. 195, with Maps.

A Dictionary of the German Terms used in Medicine. By George R. Cutter, M. D. New York: G. P. Putnam's Sons. 1879. Pp. 304. $3.

Protection of Forests a Necessity. By S. v. Dorrien. New York: For sale by B. Westerman & Co. 1879. Pp. 33.

Labor-making Machinery. By Frederick Perry Powers. New York: G. P. Putnam's Sons. 1880. 25 cents.

A Dictionary of Music and Musicians. Edited by George Grove, D. C. L. Vol. II., Part VIII. London and New York: Macmillan & Co. 1879. Per part, $1.25.

Brazilian Corals and Coral Reefs. By Richard Rathbun. Illustrated. Pp. 13. Reprinted from "The American Naturalist."

A List of Brazilian Echinoderms. By Richard Rathbun. Pp. 20. From "Transactions of Connecticut Academy of Sciences."

On the Present Status of Passus Domesticus in America. By Dr. Elliott Coues. Pp. 18.

The Brush-System of Electric Lighting. By C. F. Brush, M. E. Cleveland: Wiseman & Harvey. 1879. Pp. 26.

Neurotomy, a Substitute for Enucleation. By Julian J. Chisholm, M. D. Richmond: J. W. Fergusson print. 1879. Pp. 16.

The Geological and Natural History Survey of Minnesota. Seventh Annual Report for the Year 1878. Minneapolis: Johnson, Smith & Harrison. 1879.

Abuses in Medicine. A Lecture. By J. Logan, M. D., etc. New York: National Printing Co. 1879. Pp. 47.

How the Geometrical Lines have their Counterparts in Music. By Isaac L. Rice. New York: Asa K. Butts. 1880. Pp. 31.

Unity Pulpit, Boston. Sermons of M. J. Savage: October 31, 1879, "The Truth about Sunday"; November 7, 1879, "The Origin of Goodness"; November 14, 1879, "The Nature of Goodness"; November 21, 1879, "Life and Death"; November 28, 1879, "The Sense of Obligation." Boston: George H. Ellis. $1.50 per year; 6 cents per copy.

Gaspard D. Coligny (Marquis de Chatillon). By Walter Besant, M. A. New York; G. P. Putnam's Sons. 1879. Pp. 282. $1.

Mechanics. By Robert Stawell Ball, F. R. S. New York: Henry Holt & Co. 1879. Pp. 170. 60 cents.

On the Fertilization of Yucca. By Thomas Mehan. Reprint from "The North American Entomologist." Pp. 4. On Sex in Castanea Americana. By same. Pp. 2. The Law governing Sex. By same. Pp. 3.

"The Kansas Review," Collin Timmons, Editor. Vol. I., No. 1. Lawrence, Kansas, November, 1879. Monthly, 75 cents per annum; 10 cents per copy.

Quarterly Report of the Chief of the Bureau of Statistics relative to the Imports, Exports, Immigration, and Emigration of the United States, for Three Months ending June 4, 1879. Washington: Government Printing-Office. Pp. 96.

Geological Survey of Alabama. Report of Progress of 1877 and 1878. By Eugene A. Smith, Ph. D., State Geologist. Montgomery, Alabama: Barrett & Brown. 1879.

Topographic, Hypsometric, and Meteorologic Report. By William Libbey, Jr., and W. W. McDonald, of the Princeton Scientific Expedition. Illustrated. New York. 1879. Pp. 83.

Investigations on Rainfall, Percolation, and Evaporation of Water from the Soil, Temperature of Soil and Air, etc., etc., at the Massachusetts Agriculturist College, Amherst, Massachusetts. By Professor Levi Stockbridge. Boston: Rand, Avery & Co. 1879. Pp. 38.

American Science Series. Astronomy. By Simon Newcomb and Edward S. Holden. Henry Holt & Co. 512 pages. Price $2.50.

POPULAR MISCELLANY.

Education of the Color-Sense.—Though it is but a few years since general attention has been directed to the subject of color-blindness, the study of its phenomena has shown that there are two forms of the defect, not perhaps sharply separable, but nevertheless quite distinct. In one form there appears to be simply an imperfect or undeveloped sense of color, the power of distinguishing the different colors, though not wholly absent, being far below the normal. In the other form of the defect there is an entire inability to recognize one or more of the primary colors—that is, the blindness is complete so far as particular colors are concerned. Dr. Swan M. Burnett, surgeon in charge of the Ophthalmic Division of the Central Dispensary in Washington, in a short paper entitled "A Systematic Method for the Education of the Color-Sense in Children," expresses the opinion that cases of the first-mentioned

variety are susceptible of decided improvement by early and persistent training of the individual. In cases of the other kind, however, which are generally hereditary, he believes that amelioration can be brought about, if at all, only by a course of education applied to successive generations. The author finds fault with the general neglect of the subject in our schools, and also with the methods practiced in the few instances where such training has been attempted. In the Washington schools the practice is to use a chart on which the various colors are painted. These colors soon become so faded and dim as to no longer represent what was originally intended; and, even with this imperfect chart, no systematic instruction is given in the comparison of the colors. The first requisite, in Dr. Burnett's opinion, for successfully teaching color to children is, that the method shall be simple and easy. The study should also be made interesting, so that the children will pursue it more as a diversion than a task. Each child should be taught separately, but the instruction may be carried on in such a manner that the other children can participate. As the main object is to enable the child to discriminate between the various colors, the comparison of one color with another will be the principal part of the work. But the pupil should at the same time be taught the names of the colors and shades, so as to be able to convey the impressions he has received in definite language. To carry out these indications in a simple and effective way, there are required—first, a set of sample colors with which comparisons are to be made; and, second, a collection of colors from which the pupil may choose such as are to be compared with the sample. For the former, Dr. Burnett recommends the following: "Take a half-sheet of white perforated cardboard (42 × 26 cm.) with the largest size perforations, and work into it, with Berlin wool, bars 18 cm. in length and 35 mm. in width, of each of the following colors: red, green, and blue, with a distance of 1·5 cm. between them. These should be as pure as possible, and represent the three primary colors. Then, beginning 3 cm. below, work in at the same distances apart each of the following colors of medium shade and as pure as can be got: purple, orange, yellow, pink, brown, and gray. A single skein of Berlin wool is generally enough to work a bar of the required length and width, which is sufficiently large to be seen distinctly across any ordinary schoolroom by a normal eye. This card is to be placed on a white background on the wall in sight of all the pupils." In the process of instruction the pupils are first familiarized with this card, and with the names of the colors represented on it, and, when able to designate each of these correctly, the teacher will explain what is meant by a "shade," and, taking a package of Berlin wools containing all the shades of the nine colors on the card, will pick out and exhibit to the class all the shades of one of the colors. After this, the shades are thoroughly mixed with the other colors in the pile, and the pupils are then called upon to do the choosing, arranging them in regular order from darkest to lightest. The same process is to be repeated with each of the colors on the card.

Population of Africa.—Accurate statistics of the population of Africa, and especially of the interior portions of the continent, are of course not yet obtainable, and it will probably be many years before several of the populous districts now known will be sufficiently accessible for a thorough census; but much important information has been gathered about the distribution of the inhabitants and the density of the population in the different parts of the country. In the region of the great lakes, for example, there are countries as thickly peopled as many of the states of Europe—relatively small areas which, according to Stanley, possess millions of inhabitants. Behna states that the negro regions are by far the most populous, while the desert parts represent the other extreme. M. A. Rabaud, in a paper published in the "Bulletin of the Marseilles Geographical Society," gives the following as the population of the different subdivisions of the continent: In the Soudan, the population is estimated at 80,000,000, or about fifty-three per square mile; the town of Bida, on the Niger, contains 80,000 inhabitants. The population of East Africa is estimated at 30,000,000, and that of Equatorial Africa at about 40,000,000. One of the latest authorities divides

the population as follows among the great families into which ethnologists have separated the peoples: Negroes, 130,000,000; Hamites, 20,000,000; Bantus, 13,000,000; Foolahs, 8,000,000; Nubians, 1,500,000; Hottentots, 50,000. This would give a total population of 172,550,000. These figures are, of course, only approximate, and both German and English geographers think them too low, the former estimating the population at 200,000,000.

About Herrings.—From statistics of the Scottish herring-fisheries, furnished by a writer in "Chambers's Journal," we may get a partial idea of the enormous productiveness and abundance of that species of fish. During a recent year the herrings taken in Scottish waters and cured were sufficient to fill one million barrels, each barrel containing an average of seven hundred fish. This quantity it must be observed represents *cured* fish only, and only those which are caught in Scotland under the superintendence of the Fishery Board. It is pretty certain that as many herrings are captured and offered for sale as fresh fish and "reds" as are cured for the markets in Scotland and offered for sale as salt herrings; which gives us the prodigious total of fourteen hundred millions withdrawn annually from the sea; and even this number, vast as it is, does not include what are used in the form of white-bait, or those which are sold as sprats.

After draining the sea to such an extent, it might almost be supposed that there would be scarcely herrings enough left to suffice for a breeding-stock; but the demands of man are a mere fraction of what are taken out of the shoals. All that are captured, as well as all that are wasted during the capture, and destroyed in the process of curing, sink into insignificance when compared with the vastness of the quantities which are devoured by other enemies of the fish. Cod and ling are known to prey extensively on the herring; and a calculation, based on the number of cod and ling anhually caught under the auspices of the Scottish Board of Fisheries (three million five hundred thousand were taken in 1876), assumes that there is a capital stock of these fish in the Scottish firths and seas of seventy million individuals; and that each individual consumes four hundred and twenty herrings per annum, which at the rate of two herrings every day for seven months in the year, shows a consumption of twenty-nine thousand four hundred million individual herrings. Nor does the account stop at this point. The commissioners who recently collected information on the Scottish herring-fisheries, assume that in Scotland alone the gannet (a sea-bird) will annually draw on the shoals to the extent of one thousand one hundred and ten million herrings! In addition to dog-fish, cod, gannets, and other sea-birds, the herring has many other enemies; porpoises, seals, coal-fish, and other predaceous fishes are constantly lying in wait to fall upon and devour them. A female herring, we know, yields over thirty thousand eggs; but at the shoaling-time myriads of those eggs are devoured by a variety of enemies; besides which, hundreds of thousands of the eggs are never touched by the fructifying milt of the male fish, and so perish in the waters.

A Fabled Eastern City.—In a communication to the Royal Asiatic Society of Bombay, M. C. Doughty gives an account of a visit to the so-called rock city of El-Hejjer, which lies upon the Haj road in Arabia, at twenty camel-journeys' distance from Damascus, and about which many extravagant stories are current among the Arabs. In the days of Ptolemy, who calls it Egra, the place was an emporium on the trade-road of gold and frankincense to Syria. Having got there after great fatigue, Mr. Doughty found the fabled seven cities of the Arabs —said to be hewed in as many mountains— to be about a hundred funereal chambers excavated in the sandstone rocks. The city appears, by the traces remaining of foundations, to have been a cluster of four or five palm villages in clay, each surrounded by a wall in the ordinary Arab fashion. In their interiors the funereal monuments are plain sepulchral chambers with sunken tombs in the floor and recesses, while in the walls are shallow shelves of a man's length. Inscriptions are seen handsomely engraved in a panel above the doorways in many of the monuments. Above these again, in the nobler monuments, there is very commonly

the thick figure of a bird with outstretched wings. The Arabs say it is a buzzard or a falcon, but Mr. Doughty suggests that the effigies are those of the mortuary owls of the old Arabians. Mr. Doughty's visit has disposed of the singular fables propagated by the Arabs as well as by Turkish and Persian pilgrims, and which, he says, have been accepted in some works of learned Orientalists in Europe.

Cases of Remarkable Precocity.—From an entertaining paper in "Chambers's Journal" we select a few instances of "precocious cleverness." Anne Maria Schurmann was, in her day, the boast of Germany. At the age of six, and without instruction, she cut in paper the most delicate figures; at eight, she learned in a few days to paint flowers, which, it should be added, were highly esteemed; and two years later it cost her only five hours' application to learn the art of embroidering with elegance. Her talents for higher attainments, we are told, did not develop themselves till she was twelve years of age, when they were discovered in the following manner: Her brothers were studying in the apartment where she sat, and it was noticed that, whenever their memories failed in the recital of their lessons, the little girl prompted them without any previous knowledge of their tasks except what she had gained from hearing the boys con them over. In her education she made extraordinary progress, and is said to have perfectly understood the German, Low-Dutch, French, English, Latin, Greek, Italian, Hebrew, Syriac, Chaldean, Arabic, and Ethiopian languages. Her knowledge of science and her skill in music, painting, and sculpture were also extraordinary; and her talent for modeling was shown by the wax portrait she contrived to make of herself with the aid of a mirror.

Another prodigy was Dorothy Schlozer, a Hanoverian lady, who was thought worthy of the highest academical honors of the University of Göttingen, and had the degree of Doctor in Philosophy conferred upon her when she was only seventeen years of age. Before she was three years old she was taught Low-German; and three years later learned French and German; and, after receiving ten lessons in geometry, was able to answer abstruse questions. Other languages were next acquired with singular rapidity; and before she was fourteen she knew Latin and Greek, and had become a good classical scholar. She also made herself acquainted with almost every branch of polite literature, as well as many of the sciences. As an instance of this lady's indefatigable industry, it may be mentioned that she visited the deepest mines in the Harz Forest in the common garb of a laborer, to gain proficiency in mineralogy.

It is said that Blaise Pascal, one of the most profound thinkers and accomplished writers of France, exhibited precocious proofs of genius, especially in mathematics, from his earliest childhood. Having been purposely kept in ignorance of geometry, lest his propensity in that direction should interfere with the prosecution of other studies, his self-prompted genius discovered for itself the elementary truths of the forbidden science. When quite a boy, he was discovered by his father in the act of demonstrating on the pavement of an old hall where he used to play, and by means of a rude diagram he traced with a piece of coal a proposition which corresponded to the thirty-second of the First Book of Euclid. At the age of sixteen he composed a tractate on conic sections, which excited great admiration. Three years later he invented his celebrated arithmetical machine; and at the age of twenty-six he had composed the greater part of his mathematical works, and made those brilliant experiments in hydrostatics and pneumatics which ranked him among the first natural philosophers of his time.

Discrimination and Memory of Sounds.—Some very extraordinary feats of memory are by the "Scientific American" credited to a youth named Hicks, residing in Rochester, New York. Hicks has not lived long in Rochester, having removed thither lately from Buffalo; yet he is able to give the numbers of nearly three hundred locomotives on hearing their bells. During the day he is employed at so great a distance from the railway that he rarely hears a passing train; but at night he can hear every train, as his house is situated near the rail-

road. Men who have for years been connected with railways admit that at most they can distinguish the sounds of only very few locomotive-bells as compared with the great number Hicks can name almost without thought. Not long ago an old switch-engine, used in the yards at Buffalo, was sent to Rochester for some special purpose. As it passed near Hicks's house he heard the bell, and remarked that the engine was number so-and-so, and that he had not heard its bell for six years. A boarder in the house ran to the railroad and found that the number given was the correct one. Not long since the young man went to Syracuse, and, while there, hearing an engine coming out of the round-house, remarked to a friend that he knew the bell, though he had not heard it in five years. The number which he gave proved to be the correct one.

Lubbock on Science in the Primary Schools.—Sir John Lubbock, advocating in the British House of Commons the cause of science-teaching in schools, urged that elementary science should be placed on an equality in the education-code with grammar, geography, and history. The practical difficulties in the way could be easily overcome, and his proposal, so far from upsetting the equilibrium of the code, would really establish it, seeing that, at present, the code was entirely one-sided, all knowledge of natural phenomena being excluded. It was often said, he urged, that it was ridiculous to teach "ologies" before the children could read and write thoroughly. But, in the first place, it was a misnomer to call the lessons he proposed "ologies"; secondly, it should be remembered that, when children were learning to read, they had to read something, and the question was what that something was to be. He wished for nothing difficult or abstruse, nothing beyond the range of the children's minds and daily experience. "In mechanics, the simple forces might be explained to them—why carts were put on wheels, how levers and pulleys acted, the use of the screw and wedge; then the nature and relative distances of the principal heavenly bodies, the primary facts relating to air and water in agricultural districts, the character of the soil, the reason for the rotation of crops, the origin and principal qualities of such substances as chalk, coal, iron, copper, etc.; the succession of the seasons, the flow of rivers, the growth of plants; the fundamental rules of health, the necessity for ventilation and cleanliness, and, last, not least, the need for industry, frugality, and economy. Explanations of these simple and every-day things would be most interesting and useful to the children. So far from cramming and confusing them, you would introduce light and order into their minds, and give them an interest in their lessons, which, under the present system, they rarely felt."

Ancient Uses of Cork.—A writer in the "Pharmaceutical Journal" has collected a large amount of interesting information on the subject of the cork-tree and its bark, and the uses of the latter in both ancient and modern times. The tree, and the application of its bark to useful purposes, was well known to the Egyptians, Greeks, and Romans. The former used to construct their coffins of this material. Theophrastus, the Greek philosopher, who wrote on botany, etc., four centuries B. C., mentions this tree among the oaks, under the name of *phellus*, and says that it has a thick, fleshy bark, which must be stripped off every three years to prevent it from perishing. He adds that it was so light as never to sink in water, and on that account might be used for many purposes. Pliny describes the tree under the name of *suber*, and relates everything said by Theophrastus of *phellus*. From his account we learn that the Roman fishermen used it as floats to their nets and fishing-tackle, and as buoys to their anchors. The use of these buoys in saving life appears to have been well known to the ancients, for Lucian ("Epist. 1," 17) mentions that two men, one of whom had fallen into the sea, and another who jumped after to afford him assistance, were saved by means of an anchor-buoy. The use of this substance in assisting swimmers was not unknown to the Romans. By Plutarchus, in his "Vita Camilli," we are told that, when the imperial city was besieged by the Gauls, Camillus sent a Roman to the Capitol, who, to avoid the enemy, swam the Tiber with

corks under him, his clothes being bound upon his head, and was fortunate enough to succeed in the attempt. The use of cork for stoppers was not entirely unknown to the Romans, and instances of its being thus employed may be seen in Cato's "De Re Rusticâ," cap. cxx.; but its application to this purpose seems not to have been very common, or cork stoppers would have been oftener mentioned by authors who have written on agriculture and cookery, and also in the works of ancient poets. The convivial customs of those days had no connection with the bottle, glass bottles being of a much later invention. Instead of having dozens of sparkling champagne or hock, to be liberated from the bottle by the corkscrew, at their feasts, the guests filled their drinking-cups of gold, silver, crystal, or beech-wood from a two-handled amphora, a kind of earthenware pitcher in which their choice wines used to be kept. The mouths of these vessels were stopped with wood, and covered with a mastic, composed of pitch, chalk, and oil, to prevent air spoiling the wine or evaporation taking place. Columella, who wrote one of the earliest works on agriculture, gives directions for preparing this cement. Pliny, in describing the cork-tree, says it is smaller than the oak, and its acorns of the very worst quality. He tells us the cork-tree did not grow throughout Italy, and in no part whatever of Gaul. At the present day it is abundant in France, and Fee states that the acorns of *Quercus suber* are of an agreeable flavor, and the hams of Bayonne are said to owe their high reputation from the pigs having fed on the acorns of the cork-tree. Some ancient authors speak of the cork-tree as the female of the holm-oak (*Quercus ilex*), and in countries where the holm does not grow, they used to substitute the wood of the cork-tree.

Traditional Origin of Social Distinctions.—In the latter part of the fourteenth century social distinctions became the subject of theological controversy in England—the Lollards, a religious association including large numbers of the common people, maintaining the natural equality of man; while the Roman Catholic preachers, on the other hand, encouraged the belief that the division of society into distinct classes was a permanent judgment of God, the origin of which, according to Alexander Barclay, a poetical writer in the reign of Henry VII., they thus accounted for: "One day, while Adam was absent occupied with his agricultural labors, Eve sat at home on their threshold with all her children about her, when suddenly she became aware of the approach of the Creator, and ashamed of the great number of them, and fearful that her productiveness might be misinterpreted, she hurriedly concealed those which were the least well-favored; 'some of them she placed under hay, some under straw and chaff, some in the chimney, and some in a tub of draff; but such as were fair and well made she wisely and cunningly kept with her.' God told her that he had come to see her children that he might promote them in their different degrees, upon which she presented them in the order of their birth. God then ordained the eldest to be an emperor, the second to be a king, and the third a duke to guide an army; of the rest he made earls, lords, barons, squires, knights, and hardy champions; some he appointed to be 'judges, mayors, and governors, merchants, sheriffs and protectors, aldermen and burgesses.' While all this was going on, Eve began to think of her other children, and unwilling that they should lose their share of honors, she now produced them from their hiding-places. They appeared, with their hair rough and powdered with chaff, some full of straws, and some covered with cobwebs and dust, 'that anybody might be frightened at the sight of them.' They were black with dirt, ill-favored in countenance, and misshapen in stature, and God did not conceal his disgust. 'None,' he said, 'can make a vessel of silver out of an earthen pitcher or goodly silk out of a goat's fleece, or a bright sword of a cow's tail; neither will I, though I can, make a noble gentleman out of a vile villain. You shall all be plowmen and tillers of the ground, to keep oxen and hogs, to dig and delve, and hedge and dike, and in this wise shall ye live in endless servitude. Even the townsmen shall laugh you to scorn; yet some of you shall be allowed to dwell in cities, and shall be admitted to such occupations

as those of makers of puddings, butchers, cobblers, tinkers, costard-mongers, hostlers, or daubers.'" Such, the teller of the story informs us, was gravely taught as the beginning of servile labor.

Experiments in Punishment.—The present convict system of England is an outgrowth of the transportation system, which it has supplanted. It has grown up by successive alterations and improvements, made in accordance with varying circumstances and demands; and, to understand it fully, it is necessary to know something of the various experiments which have from time to time been tried with different methods of punishment. But, without going into this part of the subject, we give below the conclusions of a writer in the "Nineteenth Century" regarding the principles which experience seems to have established. They are: "1. That a well-devised system of secondary punishment should provide for subjecting those sentenced to it to a uniform course of penal deterrent discipline. 2. That every means possible should be adopted for developing and working on the higher feelings of the prisoners directly by moral, religious, and secular instruction, and indirectly by insuring industry, good conduct, and discipline, through appealing to the hope of advantage or reward, as well as by the fear of punishment. 3. That, with a view to deterrence as well as reformation, it is desirable that the first part of every sentence should be undergone on the separate system, as developed at Pentonville. 4. That, before discharging the convict to a full or modified degree of liberty, he should be subjected to further training, in which he should be associated under supervision, while at labor, but separated at all other times. 5. That properly constructed prison-buildings, providing among other things for this separation, are all-important requisites for the success of the system. 6. That employment should be provided, and industry enforced or encouraged for all. 7. That care should be taken to select and train a good staff of skilled and responsible officials to supervise and carry on the work of the convict establishments, and means adopted to prevent their work being hindered or defeated by the prisoners being brought into close contact, on works or otherwise, with free men who were under no such responsibilities. 8. That those who on discharge are disposed to follow honest courses should be guided and assisted in their endeavors, and that a careful watch should be kept over all till they have reëstablished their character."

Anthropometric Observation.—The report of the Anthropometric Committee of the British Association showed that considerable progress was made during the past year in the matter of collecting valuable statistical information. Returns had been obtained, giving the birthplace, origin, and sex, age, height and weight, strength of arm, and eyesight, of pupils at sundry public schools, London policemen and letter-sorters, workmen, rifle volunteers, soldiers, and criminals. By this means the committee were put in possession of nearly 12,000 original observations on the main question of weight and height in relation to age, in addition to 50,000 already collected. The committee submitted a series of tables made up from the information contained in the returns. From these it was shown that the London letter-sorters were the lowest in height, the average heights between the ages of twenty and thirty-five being 64 to 67·1 inches. The letter-sorters were also at the bottom of the weight table, their average weights in pounds being 122·5 to 139·9. The metropolitan police were at the head of both lists: height 69·2 to 71·5 inches and weight 122·5 to 182·7 pounds. Other tables were given, showing that the average height and weight vary with the social position and occupation of the people, and that to obtain the typical proportions of the British race it would be necessary to measure a certain number of individuals of each class. Taking the census of 1871, they find that a model community—that is, a community which would exhibit the typical proportions of the British race—must consist of 14·82 per cent. of the non-laboring class, 47·46 per cent. of the laboring class, and 37·72 per cent. of the artisan and operative class. It is found that the full stature is reached in the professional class at twenty-one years, and in the artisan class between twenty-five and thirty years. The growth in weight does not cease with that of the stature, but continues slowly in both classes up to the thirtieth year.

NOTES.

"NATURE" records the death of Mr. Henry Negretti at the age of sixty-two years. He was the well-known optician, and the inventor of the deep-sea thermometer which bears his name.

ON the authority of a fish-dealer at Sackett's Harbor, Mr. Seth Green states that shad in considerable numbers, and from two to four pounds' weight, were caught in the nets set for whitefish near Sackett's Harbor, in Lake Ontario, last summer. He thinks the fish have never visited salt-water, but are landlocked, and may form a permanent addition to the fauna of the lake. If this is confirmed, we have in it an interesting example of the adaptation of an organism to new conditions, the shad being a salt-water fish, frequenting fresh-water only at the spawning-season. It will also be interesting to observe the extent of the modifications likely to follow such a change of habit.

LANGUISHING scientific organizations and lukewarm members of the same have, in the career of the Portland (Maine) Natural History Society, an example that should awaken their interest and arouse their activity. This society was incorporated in 1850, has been burned out several times, losing almost everything; but has nevertheless maintained its organization, and, largely through the interest and personal effort of Mr. C. B. Fuller, present curator of its museum, a very creditable collection of natural history objects has been got together again. Last winter the society purchased a site and have since erected a twelve-thousand-dollar building on it, which will, when all completed, furnish ample accommodations.

THE public will be interested to know that there are signs of renewed activity on the part of the trustees of the Lick Observatory fund. Mr. S. W. Burnham, the observer of double stars, spent the month of August on Mount Hamilton with his telescope, in order to test this site for the proposed observatory. He reports the atmospheric conditions excellent, and it is hoped that this favorable result will lead to a new interest in the project.

THE death of Dr. Eduard Fenzl, of Vienna, at the age of seventy-two years, is announced. He was Professor of Botany and Director of the Imperial Botanical Cabinet, a member of the Vienna Academy of Sciences, and Vice-President of the Vienna Horticultural Society.

IN a recent pamphlet on the history of language, Dr. Samuel Wilks aims to prove that, in its larger sense, language has its basis in the lower animals. As to the parrot's faculty of acquiring the power of speech, his observations show that "it has a vocal apparatus of a most perfect kind, that it can gather through its ear the most delicate intonations of the human voice, that it can imitate these perfectly by continued labor, and finally hold them in the memory; also, that it associates these words with certain persons who have uttered them; also, that it can invent sounds corresponding to those which have emanated from certain objects."

PROFESSOR NORDENSKJÖLD has announced his intention of starting soon on another journey of exploration to the Siberian Polar Sea. He will make the New Siberian Islands, visited in 1809–'10 by Hedenstroem, his base of operations.

The Russian monthly review, "Svet," announces a translation of Spencer's "Data of Ethics," to be published in its successive issues. As Spencer is a great favorite in Russia, the translation is being widely advertised, and a large demand for the numbers containing it is anticipated.

IN 1877 twenty-two hundred persons were injured by passing vehicles in the streets of London, most of the accidents occurring at crossings in crowded thoroughfares. In 1878 the number of such accidents rose to thirty-three hundred, or an increase of one third. On account of this large increase, measures for the further protection of pedestrians at dangerous crossings were proposed in the House of Lords, but were objected to on constitutional grounds, and subsequently withdrawn. The recent narrow escape from being run over, of a prominent official and former Lord Mayor of London, has again called attention to the danger, and now the city authorities are about to take the matter in hand.

A STRIKING example of the effect of bad conditions in increasing the fatality of epidemics is afforded by the recent outbreak of measles on the Island of Cape Clear, at the southern extremity of Ireland. This island is some three or four miles from the mainland, and contains between five and six hundred inhabitants, who live in small, low, dark, poorly-ventilated cabins, and pick up a scanty subsistence by farming and fishing. The contagion was introduced by a young girl, returning to her home from the mainland, where measles were prevalent. Of the first forty cases reported sixteen died, a mortality of forty per cent. This enormous death-rate arrested the attention of their neighbors on the mainland, and measures were at once taken for their relief. A temporary hospital with adequate sanitary provisions was established, and with this, aided by a corps of good nurses, they expected soon to arrest the epidemic.

BENJAMIN SILLIMAN.